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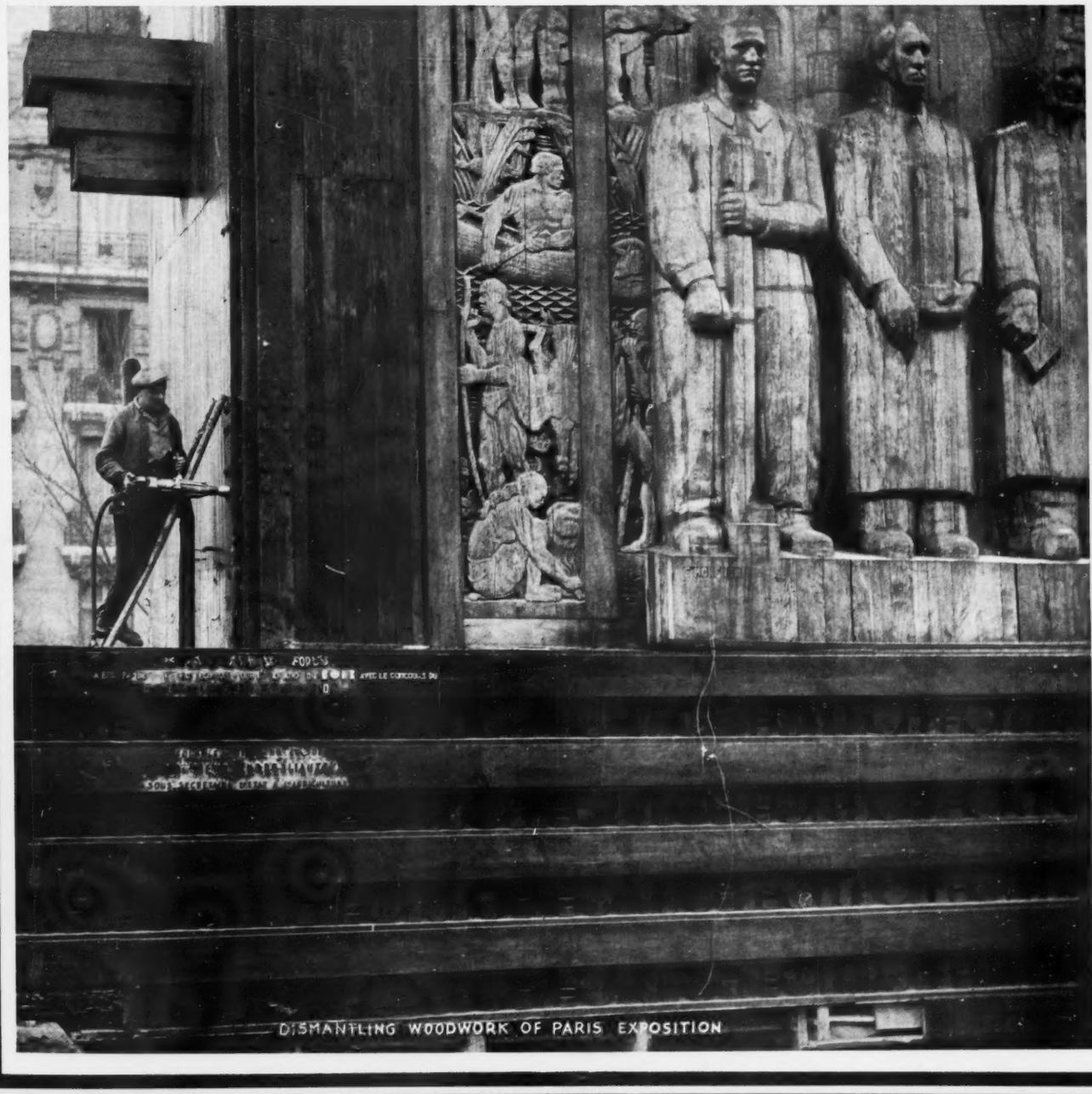

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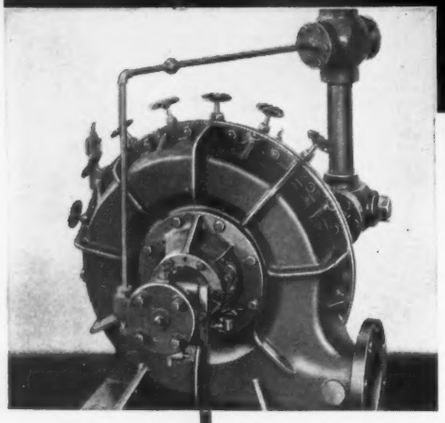

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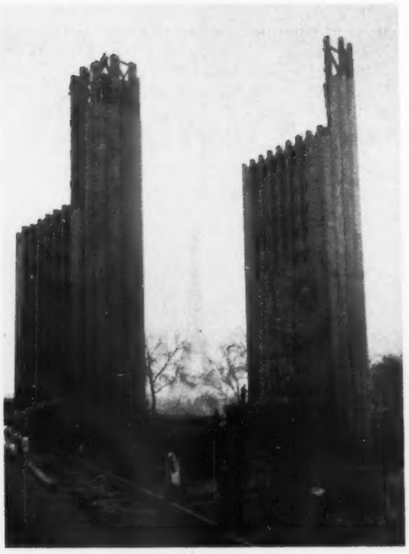

ON THE COVER

A NUMBER of large panels of wood, many of them attractively carved, were erected at the entrance to the Paris Exposition of 1937. Among these were two huge ones flanking the Alma Bridge which carried traffic across the Seine embankments at an elevated level. The wooden members entering into the construction were assembled by means of 32,000 long bolts having an aggregate weight of 90 tons. The dismantling of these huge structures was only recently undertaken. The entire assembly is illustrated above. The cover picture shows a workman running nuts off the bolts with an air-operated impact wrench.

●

IN THIS ISSUE

A THREAD of historical romance runs through the iron-and-steel industry of Pennsylvania, binding the past to the present. The care and expertness that enter into the making of Lebanon Steel Foundry castings are not entirely of modern origin. Instead, they have been handed down from father to son through generations of ironworkers in a picturesque section peopled largely by Pennsylvania Germans. Our leading article seeks to point out the significance of this heritage.

●

WITH the growth of motor traffic, Galveston has been in sore need of additional connections with the mainland. That need has now been satisfied by a fine new causeway that embodies several interesting features of design. A description of it and of its erection is presented by Robert G. Skerrett.

●

THE history of British Columbia gold mining is being continued in this issue by R. C. Rowe. It deals with the origin and growth of mines in the Rossland District.

●

THE caption of our January cover picture in which we described the *Foundation Scarboro*, used in harbor work at Saint John, N.B., as the world's largest derrick scow, was erroneous. We are informed that the floating derrick *Monarch*, with a lifting capacity of 350 tons, is the largest in North America. It is owned by Merritt-Chapman & Scott Corporation.

Compressed Air Magazine

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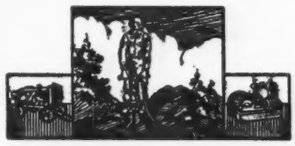
C. H. VIVIAN, *Editor* — J. W. YOUNG, *Advertising Manager*
A. M. HOFFMANN, *Assistant Editor* — J. F. KENNEY, *Business Manager*
D. Y. MARSHALL, *European Correspondent*, 243 Upper Thames St., London, E. C. 4
F. A. McLEAN, *Canadian Correspondent*, New Birks Bldg., Montreal, Quebec.



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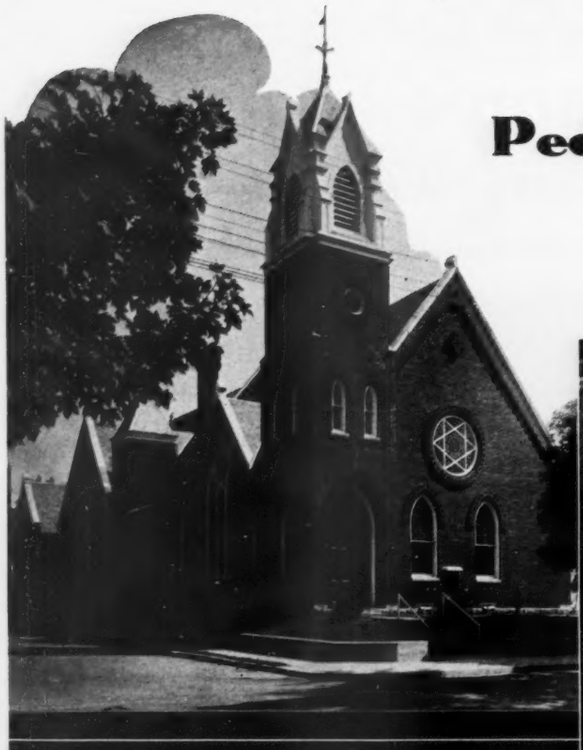
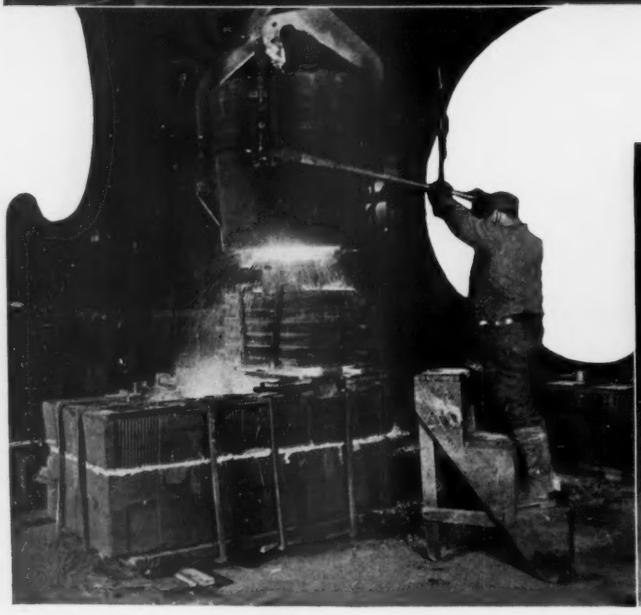
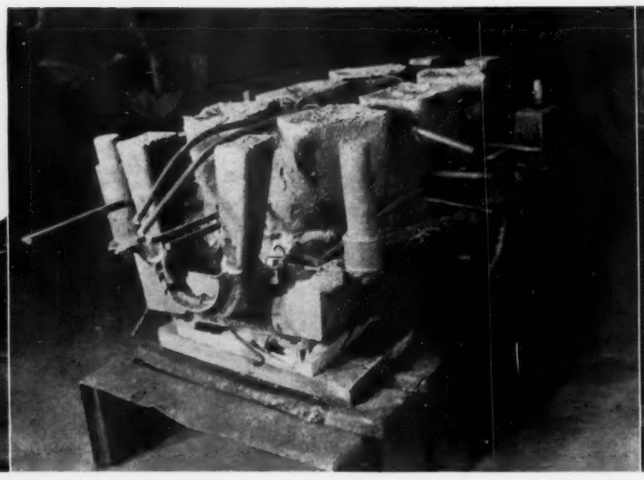
Pedigreed Steel Castings

C. H. Vivian







CASTING A PUMP CASING

Successive steps in the making of a steel casting for the lower casing of an Ingersoll-Rand Cameron Class BNT 8-stage centrifugal pump. Starting with the one above, and running counter-clockwise, the pictures show: Individual parts of the intricate coring and, beyond them, the two halves of the mold. Left—The lower half of the mold, with the coring in place. Corner—Pouring the metal from a bottom-pour ladle through a pour box having channels connecting with the heads and gates that lead to the mold cavity at various points. Below—The casting as it emerged from the mold with most of the sand shaken from it but with various reinforcing bars still in place. Across pages—After sand-blasting. Note that the heads and gates provided to insure a sound casting make up the greater part of the mass. Right—The casting with the heads and gates removed but with none of the finishing operations performed. Far right—The casting, now a casing, after it has passed through the various machining operations in the Ingersoll-Rand plant. Corner—The casing assembled in a pump, ready for shipment.

CHURCH OF THE RED ROSE

On the opposite page is shown the Zion Lutheran Church at Manheim, Pa., where a descendant of Heinrich Wilhelm Stiegel, early Pennsylvania ironmaster and glassmaker, is presented with a red rose on the second Sunday in June of each year. This ceremony was inaugurated in 1892, at the suggestion of Dr. J. H. Sieling, as a tribute to Stiegel and in commemoration of his gift, in 1772, of the land on which the original church building was erected. In that deed Stiegel stipulated that he or his heirs or assigns should be paid "in the month of June yearly forever hereafter the Rent of One Red Rose if the same shall be lawfully demanded." The Festival of the Red Rose annually draws many persons of prominence to Manheim.

CURRENT ferrous foundry practice is as new as this morning's newspaper and as ancient as the art of casting metal. It is a striking mixture of twentieth-century technology and centuries-old technique. Unlike its companion industry, the rolling mill, where virtually all procedure has been transformed during the past 40 or 50 years, the foundry still does much of its work essentially as it was performed in the early establishments of its kind. This is not an indictment of the founder, nor an implication that he is not progressive. The reverse is true, for founding is one industrial art that remains largely a handicraft. To a certain extent it can be mechanized: in fact, great strides have been taken in that direction. Nevertheless, the human equation is still a very potent factor in turning out good castings, and the indications are that it will continue to be one for a long time to come.

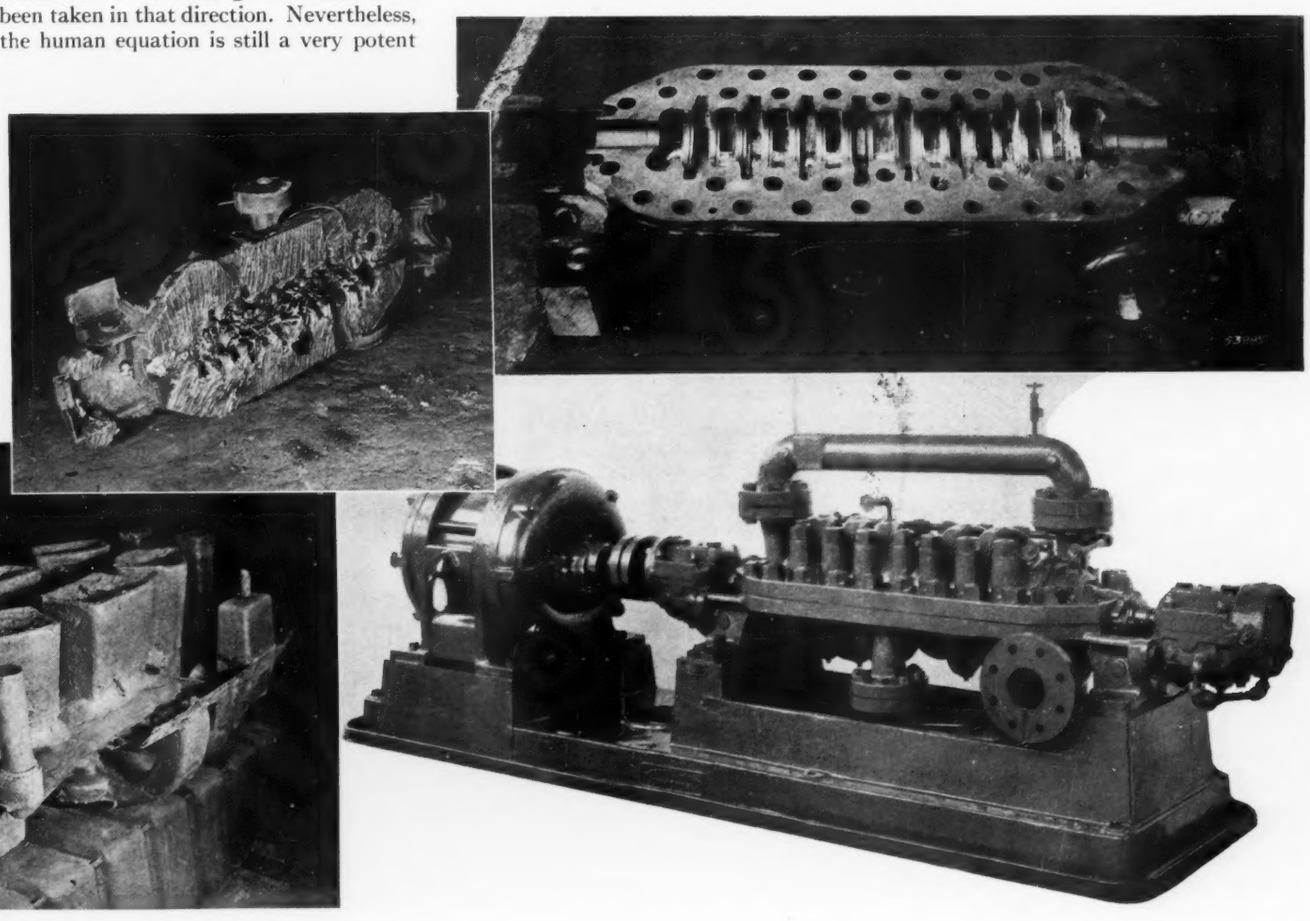
This article is concerned with steel founding, more specifically with the activities of one company in that field—the Lebanon Steel Foundry of Lebanon, Pa. The casting of steel is a relatively new development and, as might be expected, takes advantage of many modern mechanical aids. In short, it is as modern as it can be; but it clings to many time-tested, manually performed operations and services for which the keenest mechanical minds can find no satisfactory inanimate substitutes.

Collectively considered, the production of a given tonnage of rolled or forged steel requires only a small fraction of the labor that enters into the making of an equal quantity of castings. In some foundries, labor charges constitute more than half the total cost of producing carbon-steel castings of small and medium size.

The name Lebanon is a recognized synonym for high quality in steel castings, so much so that the company asks and its customers cheerfully pay a premium for certain of its products. If you seek the reason for this, you will find that there are many contributing factors; but the chief one is that Lebanon has been able to combine, in delicately adjusted proportions, the new of science and technology with human skill, experience, and judgment acquired in the course of years.

Lebanon is steeped in the traditions of the ironworker. Only a few miles to the eastward, near Pottstown, is the site of Pool Forge, where Thomas Rutter in 1716 established the first ironworks in Pennsylvania. Incidentally, it should be recorded that Pennsylvania's preëminent position in the iron and steel industry was not attained wholly by chance. In its infancy, the industry was inspired and aided by William Penn who, having owned iron furnaces at Hawkesworth, England, encouraged his people to search for and to exploit iron-ore deposits in the province he governed. It is significant that no effort was made to produce iron in Pennsylvania before Penn came upon the scene.

Closer still to Lebanon are the famous Cornwall iron-ore banks, which gave Pennsylvania's iron industry its greatest impetus. Their importance is attested to by the statement in the writings of the Pennsylvania Historical Commission that "the iron industry of the Susquehanna Valley did not make progress until after Peter Grubb built Cornwall Furnace in the Lebanon Region." Before Lake Superior's iron ranges were opened up, the Cornwall mines produced more iron ore than any other single property in the United States, and they continue to produce an appreciable tonnage today.



FIRST AMERICAN TUNNEL

One of the foremost reasons why Lebanon became an ironworking center at an early date was that the Union Canal provided convenient and economical facilities for shipping coal to the plants and finished products from them. The canal was projected in 1794, and some work was done on it at that time. The project was revived in 1811, but construction was not resumed until 1821 and the waterway was not opened until 1827. The canal was 77 miles long and connected the Susquehanna River at Middletown with the Schuylkill Navigation Company's canal 2 miles below Reading. At its highest point, approximately 500 feet above sea level, the Union Canal passed under a hill near Lebanon by way of the tunnel here shown. This is reported to have been the first tunnel driven in the United States. It was originally 729 feet long and was cut through solid rock. A few years ago, the Lebanon County Historical Society rebuilt the portal structures and placed a bronze marker on the hill above the canal. Because it was too small to accommodate many of the boats navigating the connecting waterways, the canal was not a financial success. It was abandoned in 1885.

Cornwall's three hills of rich magnetite passed through the hands of two owners before Peter Grubb acquired them and without either of them recognizing their value. Grubb obtained the 110-acre tract piecemeal, and not until he had it all did he reveal why he wanted it. In 1735 he set up a bloomery forge in which he made iron directly from the ore, following the method of the old Catalan forges of ancient Spain. In 1742 he built the Cornwall Furnace which, blown by a blast from a bellows operated by water power, had an initial weekly output of 25 to 30 tons of bar iron. In its production there was consumed 10,000 to 12,000 bushels of charcoal. A description of this furnace was published in COMPRESSED AIR MAGAZINE in March, 1934.

A little to the south and east of Cornwall is the site of Elizabeth Furnace, which is historically important because it was owned, successively, by Heinrich Wilhelm Stiegel and by Robert Coleman whose names remain the best known of all the early Pennsylvania ironmasters. Elizabeth Furnace was built in 1750 by John Jacob Huber. In the same year, Stiegel, a high-born German, came to this country. In addition to considerable money (one writer says as much as £40,000), he carried a letter of introduction to Huber. The latter took Stiegel into his business. Two years later Stiegel married his partner's daughter Elizabeth, and in 1757 he bought Huber's holdings and erected a larger furnace which he operated with three partners.

The business was profitable, but "Baron Stiegel," as he came to be known by his own choosing, spent more than he accumulated by buying thousands of acres of land and by living pretentiously. Inspired by the success of Caspar Wistar, in New Jersey, Stiegel conceived the idea of making glassware. He established a glass works nearby; and, aided by a high duty on imported glass, it flourished. As a result of these activities, a town began to grow up, and it was named Manheim. With bricks brought from England he built a mansion where he lived on a grand scale. Fond of pomp and ceremony, and having a knowledge of music, the Baron organized an orchestra among his workmen and often had it play for him. He had a cannon mounted on the roof of his home, and when he was expected back from one of his frequent trips a man was stationed there to watch for the approach of his coach. As soon as it was sighted, the cannon heralded his return and workmen dropped their tools and assembled with their instruments to give him a gala welcome.

Stiegel reveled in his rôle of magnanimous overlord of the domain he had set up. Now and then he preached to the villagers, and in 1772, when they organized a Zion Lutheran Church, he deeded them ground for their house of worship. In payment he exacted five shillings, to make the transaction legal, and "in the month of June yearly forever hereafter the rent of one Red Rose if the same shall be legally demanded."

From this unusual clause there has come into being one of the most colorful of ceremonies. The rental stipulation was but a gesture on Stiegel's part, he having been so fond of red roses that he is reported to have imported bushes from Germany. He demanded payment only twice during his lifetime; but in after years, through a desire to honor his memory, the congregation built a new Baron Stiegel Memorial Church and inaugurated the "Feast of Roses." On the first Sunday in June of 1892, John C. Stiegel of Harrisonburg, Va., a direct descendant of the land donor, was invited to Manheim to receive the rental; and the ceremony has since been repeated each year. It is now held on the second Sunday in June. From all the gardens of the town is selected the most beautiful red rose, which is tendered to one of Stiegel's offspring in the church filled to overflowing with hundreds of people to pay tribute to the Baron's memory and to drop red roses in the chancel. All the latter's worldly wealth melted away before he died, and he even suffered the ignominy of being imprisoned for debt. Yet his name will live long for the things he accomplished. His glassware was among the finest produced in the colonies, and examples of it are to be found in many museums.

Robert Coleman, who had come from Ireland in 1764 when sixteen years old to seek his fortune, found the beginning of it at Elizabeth Furnace. He settled in the Lebanon area, learned iron smelting in various establishments, and saved his money. In 1773 he leased Salford Forge near Norristown for three years, and when that term expired he moved to Elizabeth, taking a lease on the furnace and estate for seven years. Both had long since passed from the ownership of Stiegel, who was then living on charity. Coleman, knowing that no one could run the furnace better than the Baron, placed him in charge of it.

As a result of large orders received from the Government for cannon and shot for the Revolutionary War the business prospered, and Coleman was able to buy, successively and in thirds, the furnace and thousands of acres of land adjoining it. He added to Stiegel's original home there and occupied it until 1809. It still remains in the Coleman family, untenanted save for a caretaker but preserved essentially as it was a century and more ago. Included among its treasure of antiques are specimens of Stiegel's early stove plates and of his glassware. On a sloping hillside adjoining the house are the terraced gardens that were laid out for Robert Coleman by a landscape architect brought from France for the purpose. Washington was among Coleman's guests at Elizabeth, and at the latter's request sat for a portrait, by Gilbert Stuart, which is owned by the Coleman family.

In 1789, Robert Coleman acquired a five-sixths interest in the Cornwall mines and furnace and soon became the outstanding iron producer in Pennsylvania. He retired

from active business in 1809; but his oldest son, James, continued to operate Elizabeth Furnace while his younger sons, T. Bird and William, ran the Cornwall mines and furnace.

At this point it is of interest to digress for a moment to point out the great part these early iron manufactories played in the development of Pennsylvania. They were important in themselves because of the iron they turned out and the employment they gave; but they also exerted a far-reaching influence in stimulating other endeavors of the pioneer settlers. The first plants involved an outlay of at least £500, a considerable sum in those days, and much money accordingly came to be invested in the province. Charcoal was the only fuel, and enormous quantities of wood were required to produce it. The average furnace used 5,000 to 6,000 cords a year, representing the growth on about 240 acres of woodland. Obviously, the gathering of this wood resulted in the clearing of thousands of acres of land, which was consequently available for tilling. It is significant to note that Lancaster County, in which many of the pioneer iron furnaces were located, is today considered one of the world's finest farming regions. The fortunes accumulated by the early ironmasters percolated into many other colonial industries and thus had a continually widening effect on the general development of Pennsylvania.

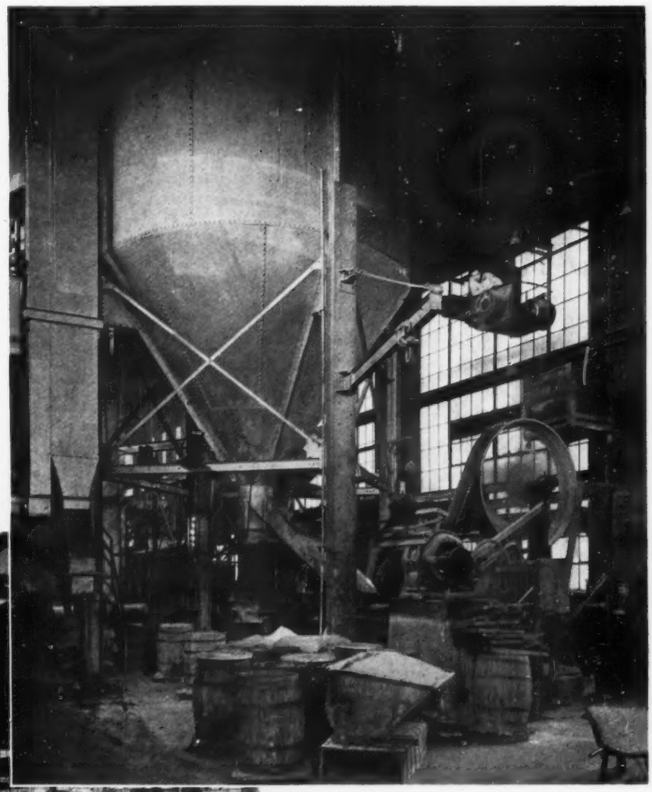
As the timber was cut, the furnaces had to go farther and farther afield for their charcoal supply, and this naturally increased costs. As a result, coal began to be used for fuel; and by the first decades of 1800 charcoal furnaces were on their way out. As was to be expected, the iron producers then started to locate their plants where transportation facilities favored cheap and easy shipment of coal to their furnaces and of the finished products from them. By reason of its situation on the Union Canal and of its proximity to the Cornwall ores, Lebanon was in a strategic position.

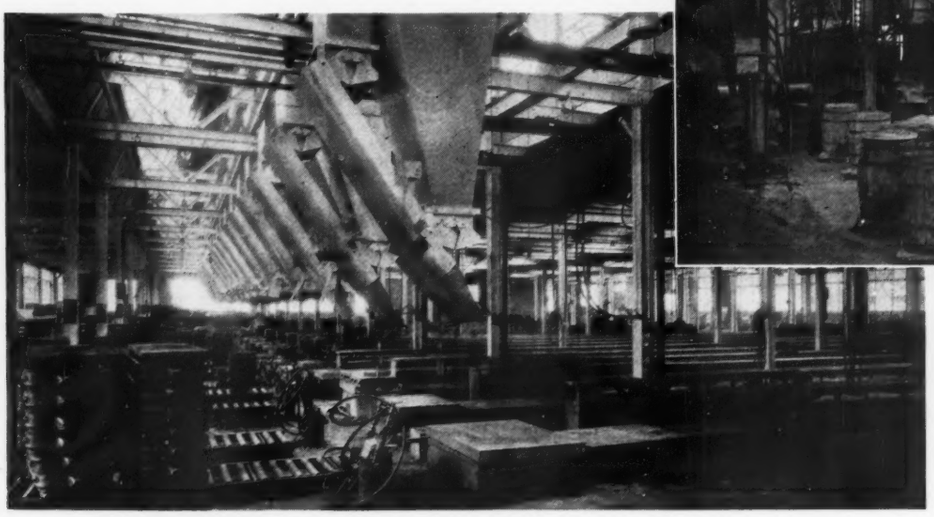
About 1825, Robert and G. Dawson Coleman, grandsons of the original Robert Coleman, built furnaces in Lebanon. That place had been a depot of supplies and a storehouse of ammunition during the Revolutionary War, and many gunsmiths had been employed there in the making of arms for the Continental Army. During the ensuing 50 years it had become increasingly important as a center of the ironworking industry, and with the establishment of the Coleman furnaces it gained in rank. Throughout the intervening years it has been the seat of various enterprises having to do with the making of iron and numerous of its products. A list of its principal industries contained in a history published in 1883 enumerates almost exclusively such plants as blast furnaces, rolling and puddling mills, stove works, boiler and engine manufactories, and foundries. Lebanon remains pretty much the same today. There has naturally been a diversification of its industries, but ironworking enterprises still predominate.

The foregoing historical sketch may appear to have little bearing on the subject of this article; but it is the opinion of those who direct the Lebanon Steel Foundry that the two matters are intimately related. As set forth at the outset, the human element is a vitally important factor in the production of good steel castings, even in this technological era. Most of Lebanon's employees are descended from a long line of ironworkers, and while it would be ridiculous to assert that they were born with the ability to perform their respective du-

CONDITIONING SAND

A steel foundry will use up to 5 tons of sand for every ton of castings produced. As this must be properly conditioned and conveyed to the various points of application in the molding and core-making departments, it is obvious that a great deal of handling is required. In this plant it is done largely with mechanical equipment. The sand-conditioning apparatus is shown at the right. Near the left edge of the picture, but not visible, is the shake-out grating. Sand removed from castings there falls on to a belt and is conveyed to the top of the large steel tank in the center. All nails and other iron are removed magnetically; and the sand is cooled and cleaned by aerating it. By mixing a suitable amount of fresh sand with this reclaimed sand, it can be used again for backing up—that is, for filling portions of the mold not adjacent to the pattern. Mixing of the two, and the addition of suitable binders and the correct amount of moisture, are accomplished in two pan mills, one of which is seen at the lower right. The mixing is done by two broad-faced wheels or mullers, at either end of a shaft, between which are plows that throw the sand in the path of the mullers. Fresh sand, which is used for forming the faces of molds that come in contact with the molten metal, also is conditioned in these mills. Sand of both kinds is stored in bins from which it is delivered to molders by the overhead trolley car and steel box at the upper right. Below is shown a row of sand bins and chutes that serves one molding department.





ties well, it is nevertheless true that they are endowed with qualifications that go to make good foundrymen.

Regardless of the industry, wherever sons follow in the footsteps of fathers for generations, the general level of performance will be high, and so it is at Lebanon. There is a singular predominance of German names among the workers, names that have persisted in the community for more than two centuries and some of which were on the payrolls of the pioneer iron-producing establishments of the area. There is likewise a surprisingly small turnover of labor. Learning the founding art as boys, the men take just pride in their skill and thoroughness of accomplishment, and find contentment in their work. Thus the thread of hereditary inclination towards a particular calling continues to lengthen and to link the past with the present. And from all indications, it will go on projecting itself into the future.

The Lebanon Steel Foundry of course represents the cumulative efforts of many persons; but it is still owned by the two men who started it: W. H. Worrilow and T. S. Quinn, now its president and treasurer, respectively. Compared with some other concerns it is not an old company, having been established in 1911. Yet, in its 28 years of existence it has witnessed many advances in the art of steel founding, for steel founding itself is not much older than some of the men identified with it, and much has been learned about it in recent years. It is generally agreed that the William Butcher Steel Works, which was later absorbed by the Midvale Steel & Ordnance Company, manufactured the first American steel castings in 1867. These were railroad-track frogs. During the following 30 years the industry was largely in a state of flux, with much experimenting being done. It was really a period of foundation-laying.

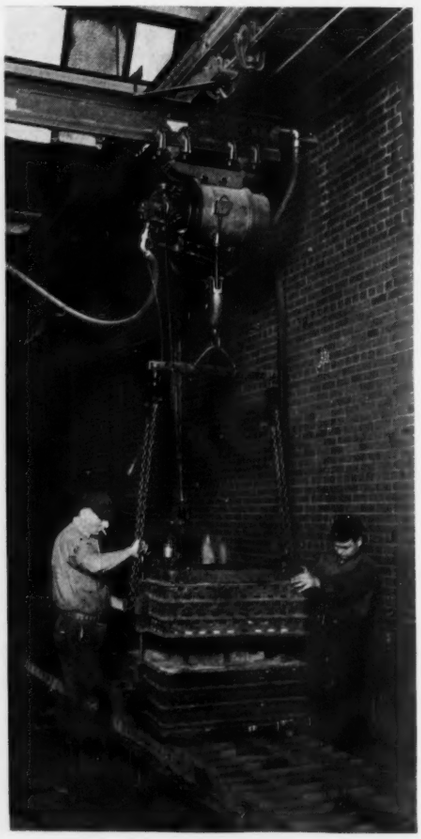
About 1895, a group of midwestern foundries succeeded in making castings in molds formed of green or unbaked sand, an achievement that greatly stimulated the industry. In cooling from its molten state, a steel casting contracts approximately ¼ inch for every foot of its length, or about twice as much as does cast iron. Where portions of the mold are interposed between sections of metal, the sand must give way or the casting will be torn apart as it contracts. As green sand offers less resistance than dry sand, its adoption simplified the making of some castings and had the further advantage of reducing their cost. Following the introduction of green-sand molds, steel castings came into widespread use in railroad equipment where they replaced many built-up parts.

In the same year in which the American steel-casting industry was born, William Siemens, prolific British inventor, and the Martin brothers in France developed a successful open-hearth melting furnace, following a decade of experimentation. Prior to that time only the crucible and Bessemer converter processes had been available. The latter was not patented until 1855 and was not fully perfected until after 1860, so that at the time of the founding of the American steel-casting industry the crucible process was the accepted one. By means of it are melted from 60 to 125 pounds of metal in each of a number of clay or graphite crucibles, which are placed within a furnace.

So long as the output of steel castings was small, this method was satisfactory, but as the industry grew, greater melting capacity was required and open-hearth furnaces and converters came into use. The electric furnace, which was developed in Italy by Stassano, was introduced in America in 1909, offering a fourth means of making steel in relatively large quantities. From that time onward, the quality of steel castings has been materially improved, making them adaptable for many applications for which those produced by earlier methods were not suitable.

The Lebanon Steel Foundry made its first castings on February 12, 1912. Its initial melting equipment consisted of two 12-pot, oil-fired crucible furnaces. After three years they were replaced by a 1-ton Heroult furnace, which was one of the first electric furnaces used in the production of steel castings in the United States. At first the principal products were castings for machine tools and for parts for the railroad and automotive industries. All were made of ordinary carbon steel. About 1926 the company began experimenting with the production of alloy-steel castings. For several years prior to that time a continually increasing number of castings had been made for manufacturers who incorporated them in equipment that had to withstand internal pressure, abnormal or subnormal temperatures, corrosion, or abrasion, or combinations of these conditions. As a result of technological advances in various industries, these service conditions were growing more and more severe and buyers of the castings were, consequently, demanding better and better foundry products. It was to comply with these demands that Lebanon entered into the alloy-steel field. This was a slow process that involved extensive research and careful procedure. It was a natural step for the firm, however, as it has built its reputation on thoroughness and painstaking attention to every detail of foundry practice.

In 1930, two 1,000-pound-capacity Ajax



AIR-OPERATED HOIST

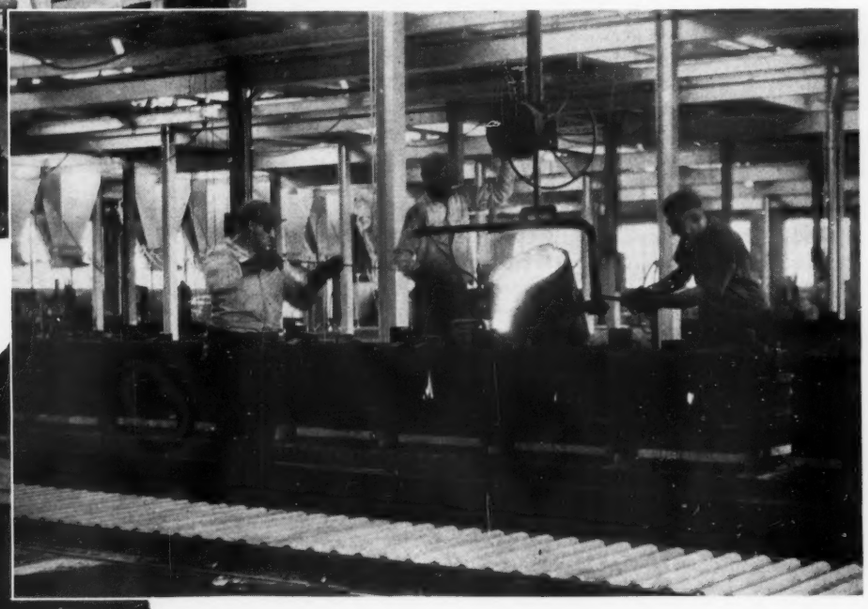
In one section of the plant are six bays, each traversed by roller conveyors. Molds are made up at one end of each conveyor and moved along toward the other end, where the pouring is done. Each of the five pairs of molders' stations is served by an Ingersoll-Rand Utility hoist with a capacity of 1,000 pounds. A similar hoist, but of 2,000 pounds capacity, serves the two conveyor lines in each bay. One of them is shown helping workers to close a mold.

RAMMING A MOLD

The flask is resting on a jolt-type molding machine which serves to consolidate the sand around the pattern by an up-and-down bumping motion imparted to it by means of a compressed-air piston. Further packing of the sand is effected with an air-operated rammer of the bench type, such as is shown here, or of the longer floor type. Two of these rammers are available at each molder's station.

SPRAYING A CORE

Cores are bodies of sand that are placed in the mold after the pattern is removed to form corresponding cavities in the casting. Two types are employed: green-sand and dry-sand cores. The difference between them is that the latter are baked and dried before use. Green-sand cores are usually made and put in position just prior to pouring: dry-sand cores are made in core boxes. Those produced in quantity are generally formed on roll-over-type machines which reverse the box and vibrate it mechanically to loosen the core so that it can be removed without damage. Before being baked, most cores are sprayed with a silica-base "wash" to improve their surfaces, a special conveyor system carrying them to the spray booth that is illustrated at the left. They are baked in ovens through which air heated by oil burners is circulated in controlled volume. The temperature and time of baking are carefully regulated. Baked cores are gone over by finishers, and are then inspected, often with the aid of gauges, to check their dimensions. Finished cores go either to the molding floor or to storage. Intricate cores are built up in the mold by assembling various individual parts.



POURING

Both bottom-pour and lip-type ladles are used. The latter, one of which is shown above, are generally employed for pouring small and medium-sized castings. The molds illustrated are on a roller conveyor, and the ladle is moved along the line from one to another. The man at the left is skimming slag from the top of the steel to prevent it from entering the mold.

CLEANING OPERATIONS

After being allowed to cool within the molds in which they have been poured, castings are shaken out of their flasks on a mechanically vibrated grating. From there they are trucked to the sand-blasting department for the removal of any adhering sand. This is done to make it easier both to detect any flaws before incurring further cleaning costs and to free the feeder gates and heads. These latter protruberances frequently weigh more than the casting itself. They are removed in various ways—flogging or sledging, special cutting machines, and the oxy-acetylene torch or electric arc being most extensively used. Next the rough surfaces left by this operation, as well as any fins or burrs, are taken off and the surface reduced to its proper contour. Large castings having flat or easily accessible faces are dressed by means of swing grinders: smaller ones by pneumatic chippers and grinders, as illustrated here. Above is shown a workman using a Size 200 chipper. In the view at the right, the interior of a pump casing is being finished with a multivane grinder. After being heat treated, castings are given a final sand-blasting. They are then ready for shipment.

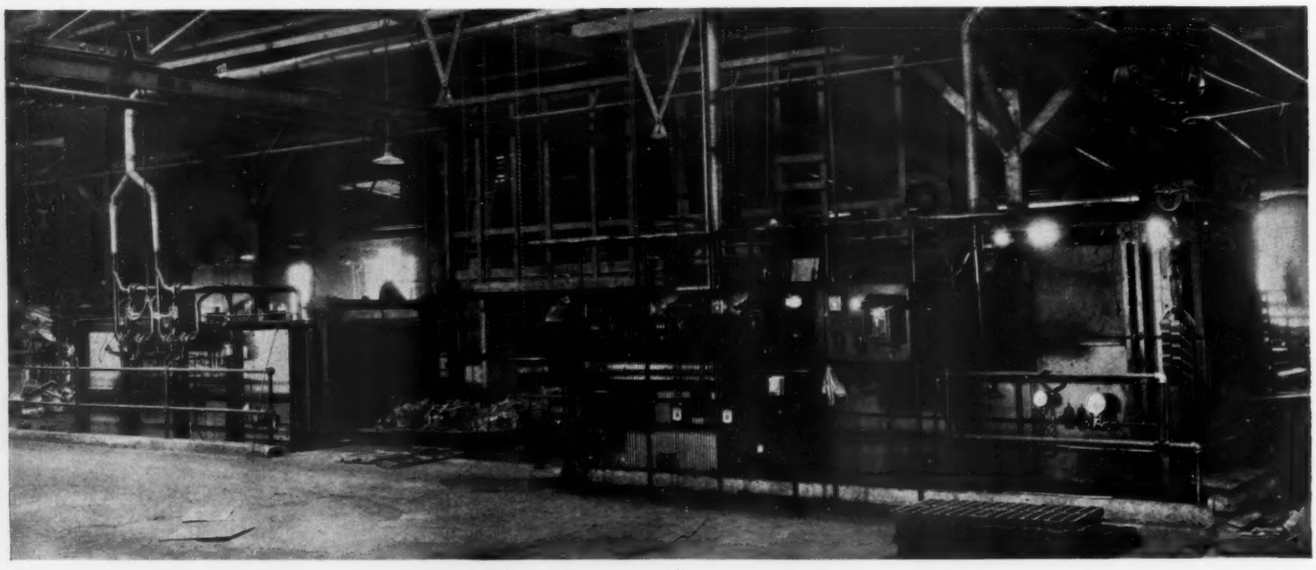
high-frequency furnaces were installed. The results obtained were so satisfactory that the company's business showed a steady increase, and it became necessary to enlarge the plant. There were set up in the new addition that was built two 6,000-pound-capacity Heroult arc-type furnaces. These are now used for the production of carbon-steel and alloy-steel castings, and with them it is possible to make single castings up to 10,000 pounds in weight, although in the ordinary run of business there are few heavier than 5,000 pounds. The original plant is now devoted almost entirely to the making of stainless-steel castings. In addition to the two 1,000-pound furnaces previously mentioned, it contains a 75-pound experimental unit.

The electric furnace has several advantages for steel-casting work. To obtain good results, particularly where there are thin sections, steel must be poured at around 3,000°F., or about 300° higher than in the case of iron. A considerable latitude in the pouring temperature is permissible with iron; but a relatively few degrees one way or the other make a pronounced difference in steel castings. The electric furnace not only makes it easy to reach the high temperature desired but also offers better opportunity to control the temperature closely. As no undesirable elements are introduced into the charge from the outside during the melting process, the electric furnace assures a material of high purity. The few impurities that are present unite with the oxygen in the furnace and are either carried off in the form of gases or entrapped in the shallow blanket of slag that forms on top of the molten metal. The continual outflow of these gases through vents in the furnace builds up a slight pressure that prevents air from entering and helps to maintain a neutral atmosphere that is very beneficial to the process of purification. The absence of undesirable gases greatly reduces oxidation and consequently lessens the likelihood of the formation of blowholes in castings. It likewise minimizes the possibility of contamination of castings by particles of oxides, or non-metallic inclusions.

A buyer of steel castings judges their quality chiefly on the basis of the following factors: 1—soundness; 2—accuracy of dimensions; 3—composition of the metal; 4—pouring temperature, which influences grain size; 5—heat treatment, which largely determines whether intricate castings will hold their shape when they are machined; and 6—finish. Depending upon the use to which a casting is to be put, one or more of these may be of greater importance than the others, but all of them receive serious consideration. The nature of the service for which most castings made by the Lebanon Steel Foundry Company are intended is such that, to be satisfactory, they must be right with respect to all the aforementioned points. To make them so requires not only technical knowledge and experience but also the skill of the individual worker, as has been mentioned before, and the exercise of extreme care and close attention to details by everyone concerned with the entire production process.

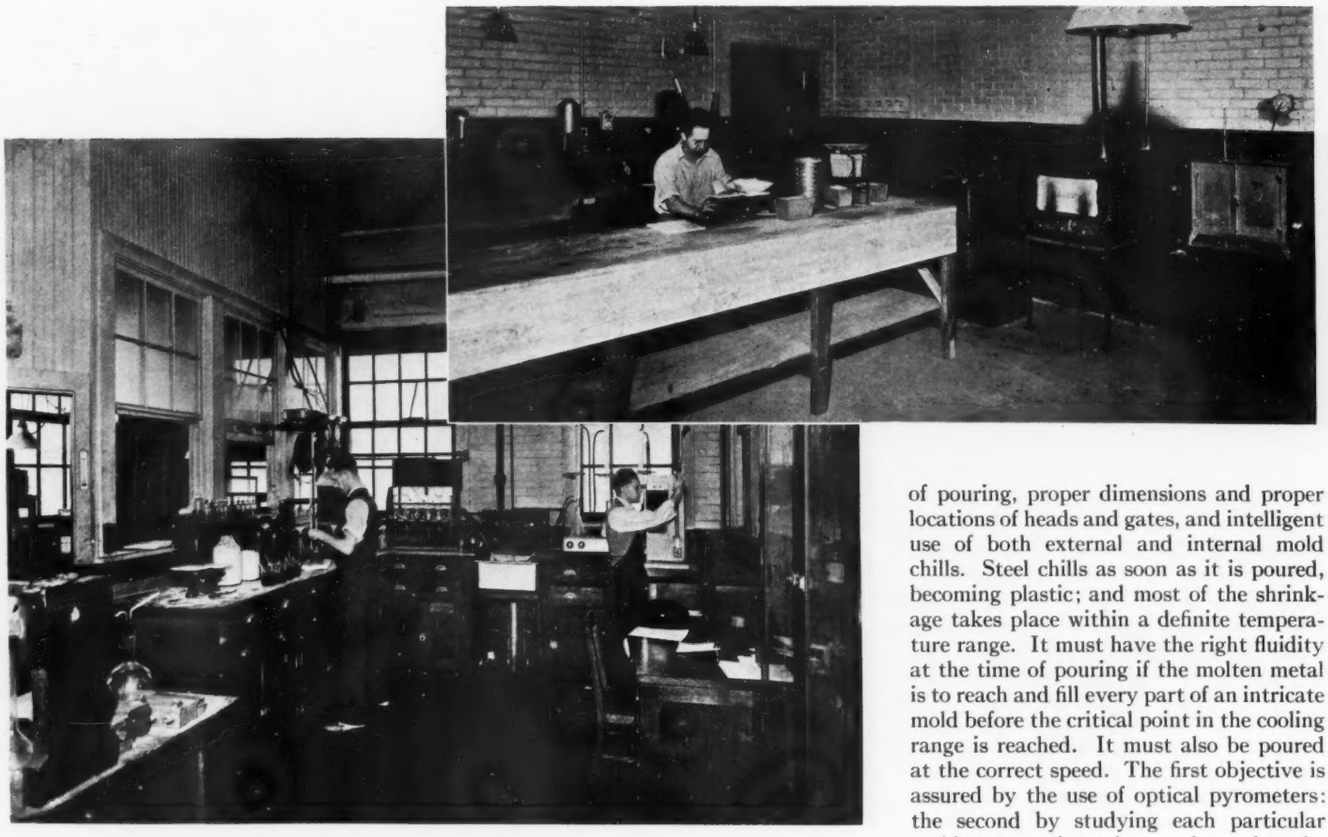
To the uninitiated the making of a casting may appear to consist simply of pouring molten metal into a cavity formed in sand. Essentially it is just that, but there are many steps to be taken before the completed casting emerges, and a little carelessness, or a comparatively minor error of omission or commission anywhere along the route, will inevitably affect the desirability of the product. If there are too many errors or too many places where things are done in slipshod fashion, the casting will be wholly unacceptable. From the making of the pattern on through the various stages of forming the molds and cores, melting and pouring the metal, cleaning and heat-treating the casting, down to the final inspection, there are many opportunities to do seemingly unimportant things wrong, or at least not quite so well as they ought to be done. That is why the human element enters so vitally into foundry procedure, and why the heritage of many ironworking generations possessed by the workers of the Lebanon district may exert, as the officials of the company believe it does, a pronounced effect upon the quality of its products.

It is not usual to think of a steel casting as something that is designed; but in a high-grade foundry such as this one great attention is paid to paving the way for a good product while it is still in the blueprint stage. The form that a casting is to take is usually determined by a designing engineer in the firm which is going to incorporate it in one of its machines. Ordinarily, such a man is not intimately acquainted with the difficulties that confront the foundryman. Oftentimes he specifies a shape that cannot fail to lead to trouble. By making one or more changes, usually simple ones, it is generally possible to produce a better casting with far less trouble and at a lower cost. In the interest of better design, the Lebanon Steel Foundry maintains close contact with its customers, with the result that consideration is given at the outset to the designing of new parts so as to eliminate casting complications. In these



HEAT-TREATING FURNACE

Following cleaning, all castings are heat treated to relieve stresses and to refine the grain structure of the metal. For this purpose is provided the modern, oil-fired, pyrometer-controlled furnace shown here. Castings are charged into it by a ram actuated by compressed air. They travel at a controlled rate through a normalizing zone, and then across an open space to give them an air quench. Some are removed at this point, while others pass on through a drawing zone, where they are reheated but to a lower temperature than that in the normalizing zone.



LABORATORY FACILITIES

Close control is maintained on the chemical and metallurgical characteristics of all castings. A corner of the chemical laboratory is shown above. As sand is one of the most important materials used in the foundry, a special laboratory (top, right) is provided for testing it. The high temperature at which steel is poured calls for sand that is resistant to fusion and disintegration. The silica content is from 95 to 98 per cent. Uniform grain size is desirable for good cohesion. Sand molds and cores must be sufficiently permeable to permit the escape of gas, and yet not so open that the metal can penetrate them. Too little moisture reacts against the firmness of the mold, and too much will cause the generation of steam and produce castings containing blow holes. Tests for all these characteristics and others are made on every carload of sand received. The sand is bought in the dry state and stored in covered concrete bins to keep out moisture, which is later added in the desired proportion.

collaborations due attention is also paid to the metallurgical aspects of the casting.

Having developed its own technique to a high degree of efficiency, the Lebanon company began about ten years ago to study European methods with a view to finding additional ways of improving its products. The outcome of these investigations was that the Lebanon Steel Foundry was granted the exclusive rights to the use of the Fischer method of making steel castings in the United States. This method was originated by the George Fischer Steel & Iron Works of Schaffhausen, Switzerland, which is recognized as the outstanding manufacturer of steel castings in Europe.

The firm was established in 1802 as a maker of fire engines. Later, bells and cannon were cast in bronze. In 1825, Johann Konrad Fischer, in collaboration with eminent British metallurgists that included Huntsman, the inventor of the crucible furnace, produced a nickel-alloy steel which became well known as "meteor" steel. The making of malleable iron was started in 1860, and soon afterward George Fischer furnished the Swiss industry with its first cast steel.

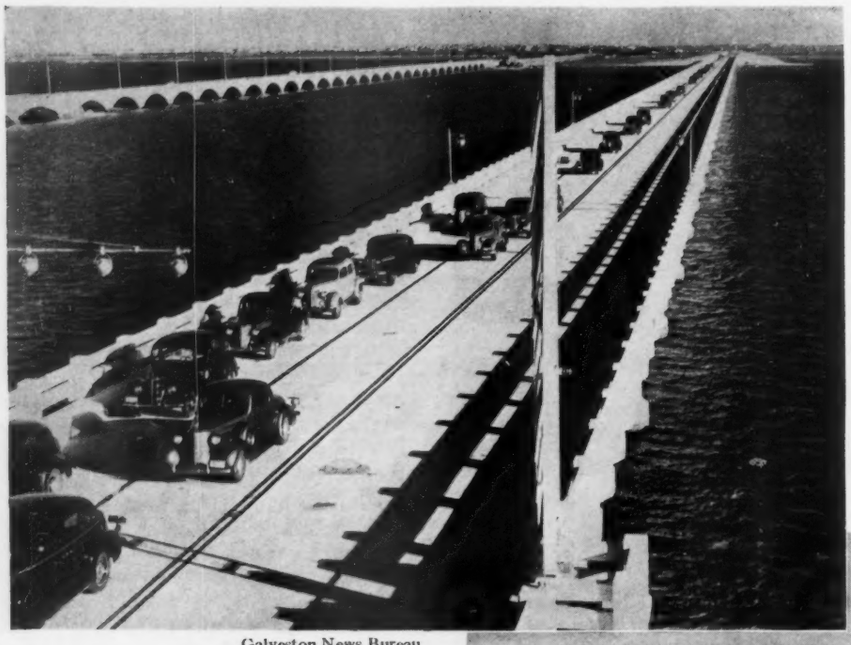
Although it includes some patentable features, the Fischer method, as its designation implies, consists largely of distinctive ways of doing essentially the same things that many other steel foundries do. It represents the result of extensive experience in procedure coupled with research designed to develop the best materials that enter into the work. In the latter classification is the preparation of the sand used in forming molds and cores. We have already mentioned the necessity of using molding sand that will not obstruct the shrinkage of a steel casting during cooling. It is just as important that the sand have the cohesiveness to stand up without crumbling when the weight of the molten metal is lodged against it, and that it have the plasticity to retain its shape when molded even where projecting corners or edges are exposed to the action of the fluid steel.

Under the heading of foundry technique, the Fischer method involves many things such as correct pouring temperature, rate of pouring, proper dimensions and proper locations of heads and gates, and intelligent use of both external and internal mold chills. Steel chills as soon as it is poured, becoming plastic; and most of the shrinkage takes place within a definite temperature range. It must have the right fluidity at the time of pouring if the molten metal is to reach and fill every part of an intricate mold before the critical point in the cooling range is reached. It must also be poured at the correct speed. The first objective is assured by the use of optical pyrometers: the second by studying each particular mold pattern in order to determine the number and the size of heads and gates and the most effective locations of these channels through which the molten metal is fed into the cavities that are to be filled. In many castings thin sections adjoin thick ones. Obviously, the thin parts tend to cool faster than the adjacent heavier ones, with the result that shrinkage stresses conducive to the formation of cracks will be set up. To compensate for this, the rate of cooling in the thick sections is accelerated by placing chills at strategic points. These chills are pieces of metal which, if they are put in the mold cavity, must be of the identical composition as the steel being poured. The shape and size of these chills, the number used, and their positioning and arrangement, all vitally affect the resultant product.

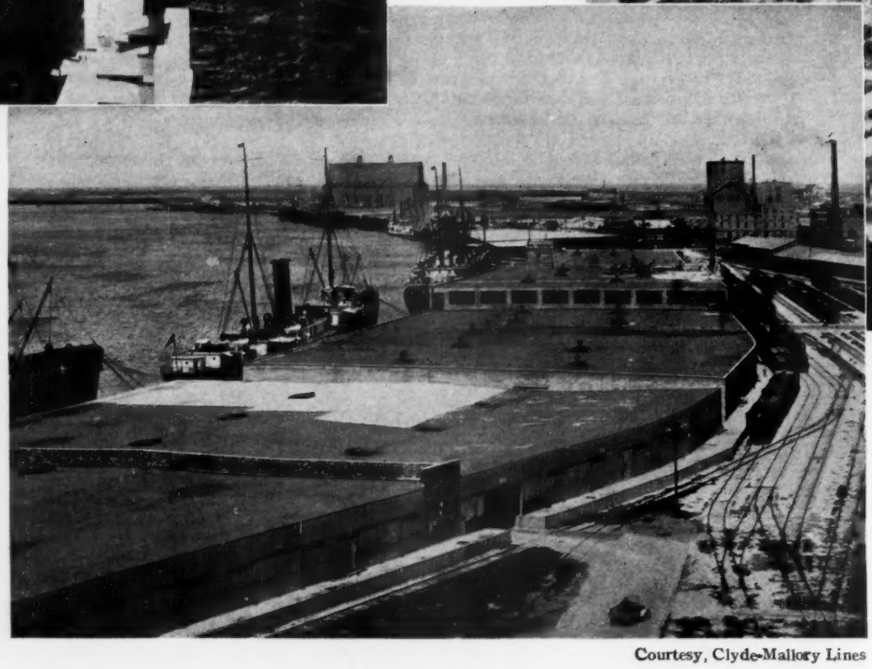
Lebanon steel castings are sold under the trade name of Circle L. They are made in a wide range of metal compositions, including numerous alloy steels. Alloying elements include chromium, vanadium, nickel, molybdenum, copper, selenium, titanium, and columbium. The list of industries that use these varied products is too long to print. Depending upon their application, the physical characteristics must be such as to resist impact, pressure, temperature extremes, abrasion, or corrosion, or combinations of two or more of these. One of the interesting materials produced in large quantities is Nipermag, which is extensively used in making permanent magnets for magnetos, radios, and many other pieces of equipment. Lebanon castings are shipped to virtually every section of the United States.

Galveston's New Causeway

Robert G. Skerrett



Galveston News Bureau



Courtesy, Clyde-Mallory Lines

GALVESTON has recently been linked with the mainland of Texas by a second modern causeway that spans a 2-mile stretch of the western arm of Galveston Bay. This viaduct, which has cost about $2,500,000, is one more concession to the continually increasing demands of motor-vehicle traffic. In its special features it represents a studied effort to provide a structure sturdy enough to withstand the violent winds and the pounding waves associated with the tropical cyclones which every now and then sweep in upon our Gulf States from the distant waters of the Caribbean Sea.

Galveston Island, upon which the City of Galveston is established, is 34 miles long and has a varying width that attains a maximum of about 2 miles. It is one of the numerous sandy offshore barriers that nature has interposed between the mainland of Texas and the open waters of the Gulf of Mexico. Behind the island and neighboring Bolivar Peninsula lies Galveston Bay with its two wide-flung east and west arms. Within that snug haven, shipping has found shelter since the days of the earliest explorers of the continent's Atlantic seaboard; and there, too, the predatory buccaneers concealed their fleet craft—the last of that piratical gentry being Jean Lafitte, who was routed out from his stronghold on Galveston Island by a United States naval force in 1821. Tradition has it that he buried there much gold and other ill-gotten booty before he slipped away to Venezuela.

Galveston Island has, successively, been under the dominion of Spain, France, Mexico, the Republic of Texas, the Confederate States, and the United States; and while it was the seat of government of the second Republic of Texas, Galveston City came into being by a charter granted by that republic in 1836. During the 103 years that have intervened, Galveston gradually acquired the impetus that has swelled her population to 60,000 and given her an outstanding position in maritime commerce. Because of her strategic coastal location and the natural riches and abundant pro-

Courtesy, Clyde-Mallory Lines

OPENING CEREMONIES

A delegation of civic authorities made the first run over the new causeway (opposite page). In the upper part of the picture is seen the paralleling older viaduct now used jointly by various railroads and some motor vehicles. The new causeway is far enough removed to be unaffected should the older structure be damaged. Below the view of the causeway is a section of Galveston's busy waterfront where ships from all parts of the world dock. The harbor is within 40 minutes' run of the open waters of the Gulf of Mexico. The larger picture shows Galveston's Gulf side with a section of the shore boulevard and its protecting sea wall, which has a length of 7½ miles and cost $4,000,000.

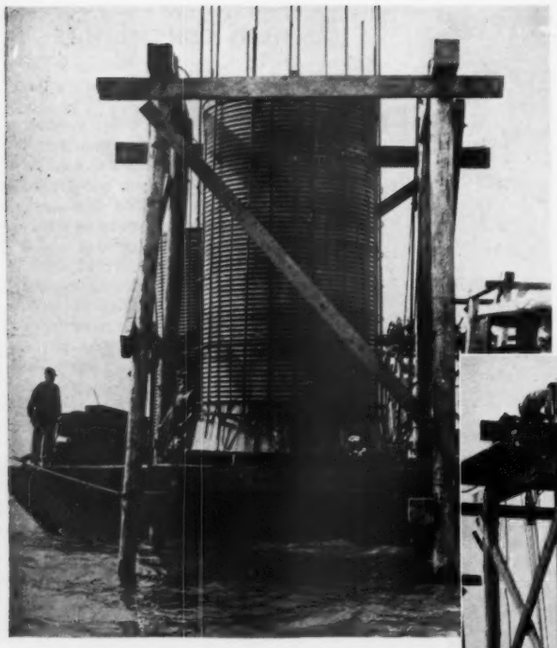
ductiveness of the vast tributary hinterland, Galveston today ranks next to the Port of New York in the value of her export trade. In recent years the ships of many nations have annually been carrying away commodities worth more than $250,000,000—the bulk cargoes consisting of cotton, sulphur, petroleum, grain, rice, etc. These products have been drawn to Galveston from different sections of Texas by the five trunk railroads that converge upon the city over a single causeway spanning the west arm of Galveston Bay.

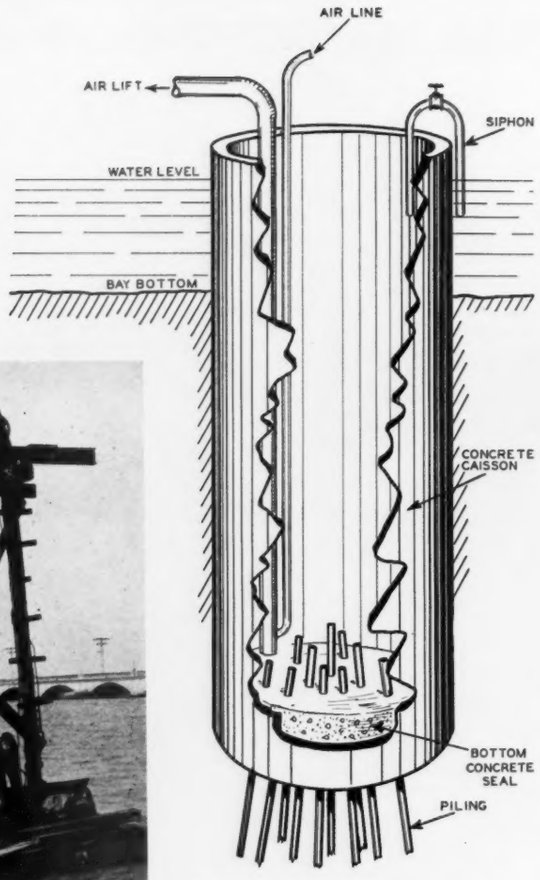
In 1900, all railroad and vehicular movement between Galveston and the mainland was over four low crossings held above the water by timber piles. Then came the catastrophe that nearly wiped out the city and, paradoxically, resulted in the revitalizing of the forces that have transformed her into a bustling seaport and a great recreational center. On September 8, 1900, a West Indian hurricane swept across the island with its center but 20 miles to the westward of Galveston. That cyclone raised the level of the storm tide about 13 feet above normal; and the winds, which attained an estimated maximum velocity of 120 miles an hour, whipped the high water into towering waves and drove them violently across the low island. Only the stoutest of the structures survived that attack. When the hours of appalling stress had passed, 6,000 of the community's 38,000 people had perished and the property losses totaled $30,000,000. The storm had demolished or rendered useless all crossings between Galveston Island and the mainland; and for a protracted period thereafter, traffic across the bay was possible only by water.

To fortify the eastern part of the island against a repetition of such destruction, Galveston, as well as the Government, constructed along the gulf front several miles of massive reinforced-concrete sea wall, 17 feet high, backed by an earth fill having a base spread of 100 feet. As a further defense, an area of about 3 square miles of the city was raised an average of 7 feet above the erstwhile grade which had nowhere been more than 9 feet above sea level. To do this, the surviving buildings were lifted and reset on pilings, and millions of cubic yards of material were dredged from the bay to provide the necessary fill. The wall and the made land formed a bulwark that has since served to prevent storm seas from again crossing the island.

While these notable engineering tasks were being pushed, the trunk-line railroads, the Galveston-Houston Electric Railway, and Galveston County conjointly financed the construction of a causeway across the West Bay. That structure, which was ready for both railway and vehicular traffic in 1912, was designed to hold its own against any hurricane that might strike Galveston in the future. Between the opposing shore-front abutments it spanned a water gap of 10,655 feet, and was composed of a central 2,455-foot, reinforced-concrete section and of two flanking earth-fill sections 3,700 feet and 4,500 feet long, respectively. The slopes of the latter were faced with concrete slabs. The central section was made up of twenty-eight 70-foot barrel arches with solid spandrels and with a draw span, 110 feet long, across the channel of the Intra-Coastal Canal. The deck level of the viaduct was approximately 16 feet above the surface of the bay, and the vehicular roadway was wide enough for two traffic lanes.

In August of 1915 another violent tropical cyclone swept inland from the Gulf of Mexico, its center passing 45 miles to the westward of Galveston. Despite the high winds and pounding seas the sea wall stood up undamaged, although the concrete paving along the surmounting boulevard was badly shattered. The city generally suffered only to a moderate extent; but the supposedly hurricane-proof causeway was largely demolished—the concrete section alone being substantially intact even though the storm seas had swept over it.





Austin Bridge Company Photos

CONSTRUCTING CAISSONS

At the upper left is shown the inner corrugated-metal form and the reinforcing steel being placed for one of the 238 caissons on which the new causeway is supported. The outer metal form was next erected, preparatory to pouring the concrete for the cylinder. In the center picture is seen the lower section of a caisson being lowered to the bay bottom. As the cylinder was sunk in the water bed it was built up at the top. At the right is a phantom sketch, not drawn to scale, illustrating the manner in which the air-lift system was used to excavate the caissons sunk in water-bearing bottom material. This was the only way in which they could be cleared out in cases where conditions prevented the use of pumps.

The earth-fill sections were washed away down to the water line: all that remained of them were the two parallel lines of concrete sheet piling that had been driven into the bay bottom to confine the toes of those structures.

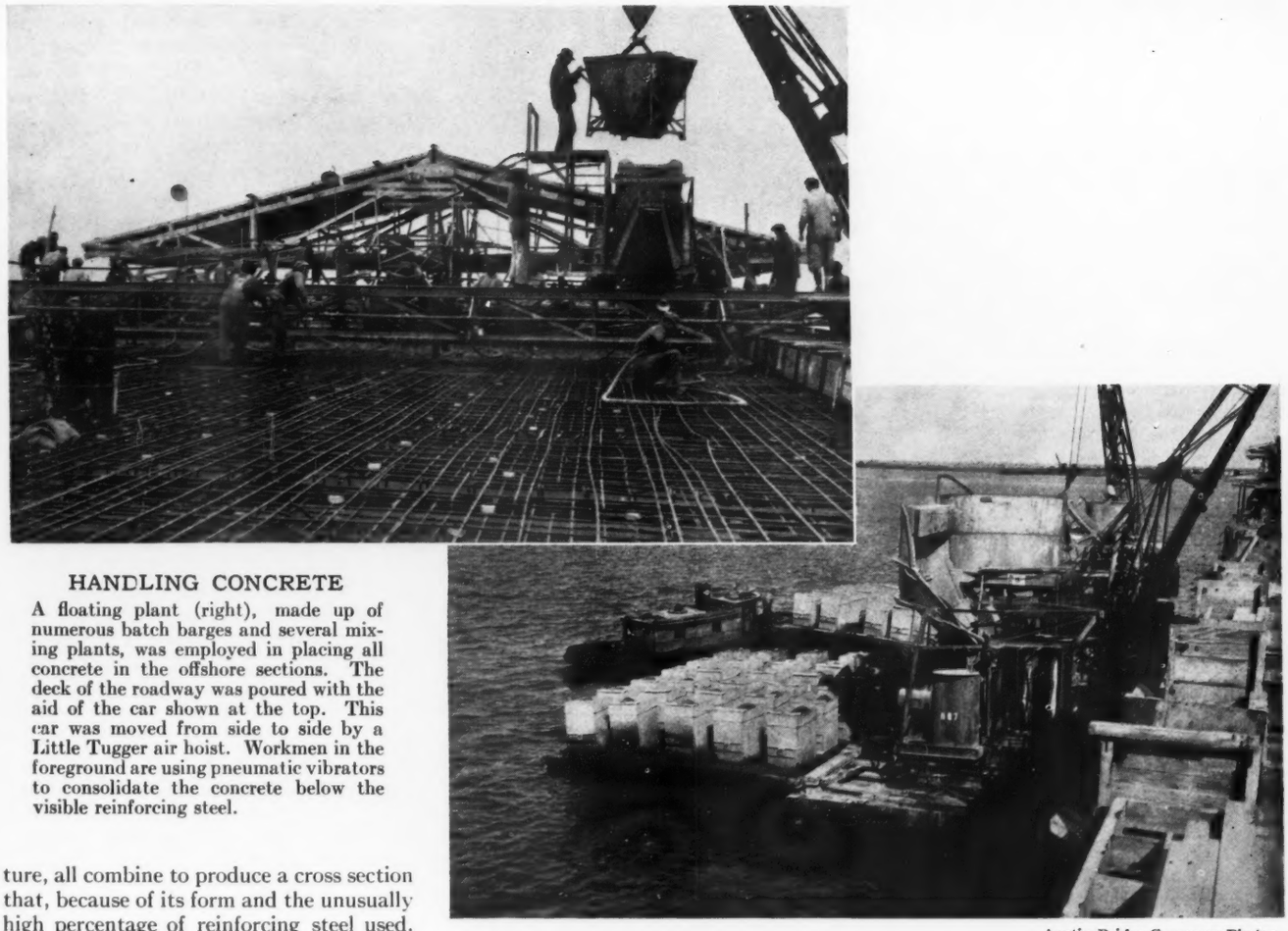
Between 1918 and 1922 the wrecked viaduct was rebuilt. To the surviving central section was added 5,530 feet of similar reinforced-concrete arch bridging, reducing to that extent the earth-fill sections adjacent to the two shore abutments and in the shallow-water areas of the crossing. No change was made in the carrying capacity of the causeway—motor traffic having at its disposal a roadway 20 feet wide which allowed no space for the turnout of disabled cars or for the use by pedestrians.

Galveston, because of her favorable climate, her wonderful, gently sloping 30-mile beach, and her other attractions, has become a great recreational resort; and her visitors annually number around 1,500,000. Many of these people arrive and depart in automobiles; and at peak periods traffic over the causeway has led to serious congestion. This situation has been intensified by the rapid increase in motor travel. The need of additional facilities became critical; and finally, in the second half of 1935, the State Highway Department of Texas, with the assistance of the Public Works Administration, was in a position to finance the construction of a second causeway for the exclusive use of motor vehicles. It was designed by The Terrell Bartlett Engineers, of San Antonio, Tex., and built by the Austin Bridge Company, of Dallas. The total cost of the crossing with its approaches was $2,160,000. Work was started in the first half of 1936, and the project was opened to the public in December of the year gone.

The new causeway crosses the West Bay 535 feet southwest of the older one, which it generally parallels, and is nearly 8,200 feet long between its water-side abutments. While the older cro[illegible]g depends upon its massiveness to s[illegible] up rigidly against wind and wave[illegible] new viaduct is so designed that most of it will offer the least practicable opposition to storm-driven waters and yet have ample strength to survive heavy impacts and the varying stresses of cyclonic winds. It is therefore flexible within purposely intended limits.

The main structure, in the words of Terrell Bartlett, consists of continuous, reinforced-concrete girders with an integral deck slab normally about 8 feet higher than that of the older crossing. The girders are in sections of three spans having a combined length of 201.5 feet between the through expansion joints. The causeway is made up of 39 such sections; and where it crosses the Intra-Coastal Canal there is a bascule span with twin leaves and with a clear passage of 105 feet between the flanking fenders. A pit pier and associate abutment are at each end of this draw span. The viaduct roadway has a width of 40 feet between curbs, and its normal elevation is 24.83. It is flanked by walkways each 2.5 feet wide and protected on the outer side by a strong concrete railing 3.5 feet high. At the ends of each of the 3-span sections the deck structure rests upon cast-steel, expansion roller bearings. Each 3-span section is carried by four pairs of transverse columns in two parallel lines 28.75 feet apart on centers. These rise from twin piers which penetrate the bay bottom to depths ranging from Elevation −28 to −40 and which, in turn, are supported by groups of piles driven with a batter and as much as 50 feet into the underlying soil—the latter figure varying with the character of the material encountered.

The transverse strut that ties the pier units together at the top, the two columns rising from each twin pier, and the adjoining transverse structure of the superstruc-



HANDLING CONCRETE

A floating plant (right), made up of numerous batch barges and several mixing plants, was employed in placing all concrete in the offshore sections. The deck of the roadway was poured with the aid of the car shown at the top. This car was moved from side to side by a Little Tugger air hoist. Workmen in the foreground are using pneumatic vibrators to consolidate the concrete below the visible reinforcing steel.

Austin Bridge Company Photos

ture, all combine to produce a cross section that, because of its form and the unusually high percentage of reinforcing steel used, is capable of meeting the severe stresses to which the causeway may be subjected during a hurricane. By placing the superstructure well above the direct sweep of waves of maximum recorded height in the bay, and by providing wide passages between the piers for the unobstructed movement of waves and storm-tide currents, the viaduct is expected to escape such damaging impacts as wrecked the older one. Thus the purposes of the designers differ radically from those of the engineers who planned the 1912 crossing. The new structure has many other interesting characteristics; but reference to them must be omitted because of lack of space.

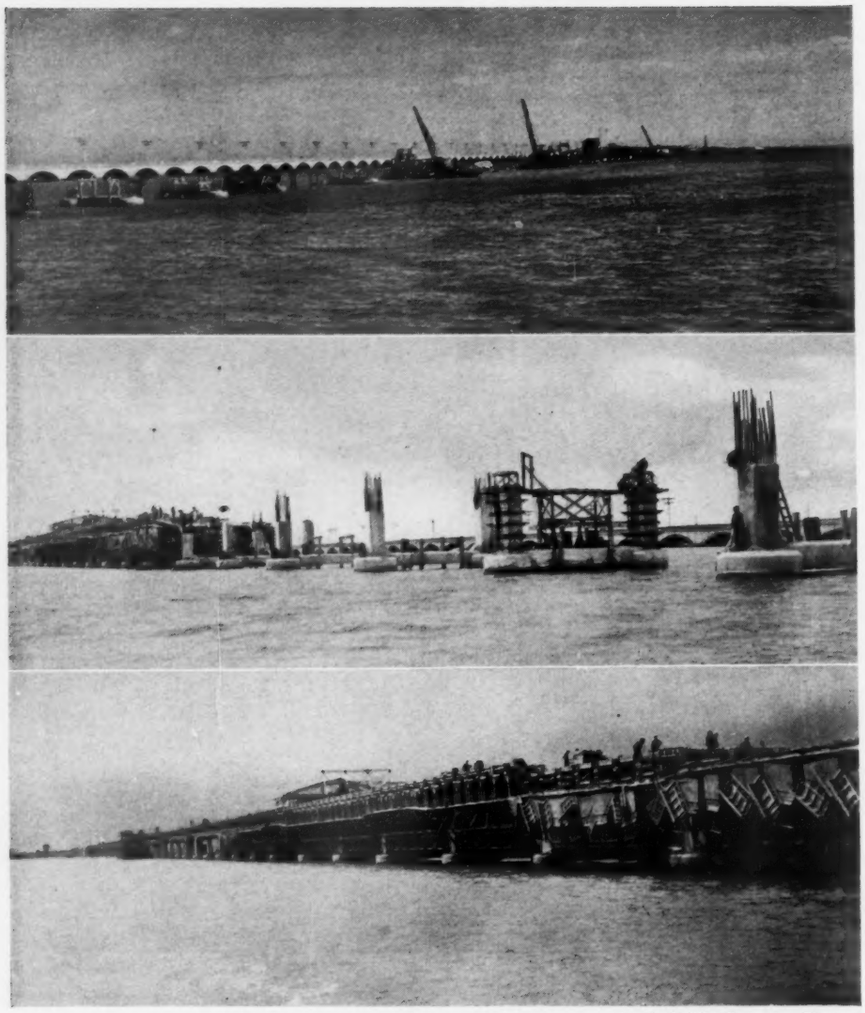
The West Bay is generally a shallow body of water, and along the line of the new causeway the depths normally range from 6 inches to a maximum of 13 feet. Between ordinary low tide and approximate mean high tide there is a difference of only 2 feet; but during extreme low tides the water's edge may withdraw as much as 1,000 feet from the accustomed shore line. The bed of the bay is variously composed of upper strata of soft mud and mixtures of sand and clay, with a substratum of harder clay offering satisfactory support for the loads on the causeway under both severe service and storm conditions. Now let us see how the Austin Bridge Company built the crossing.

Because of railroad connections which made it easy to deliver materials and equipment, the operating base was established at the mainland end of the undertaking, whence the structure was carried across the bay to the terminal abutment on the island shore. Despite the shallowness of the water along much of the route, the contractor elected to do nearly all his work with the assistance of a floating plant. To make that practicable, a canal was dug along one side of the entire causeway line and for a considerable distance along the two approach fills. This afforded a high degree of mobility. At its mainland end, the canal reached to the contractor's two supply trestles, with rail connections and facilities for handling everything needed on the job.

The substructure of the causeway necessitated the building of two abutments, of 119 twin piers, and of two rectangular piers, 36x60 feet, for the support of the bascule span. Each of the latter piers penetrates fairly hard clay at Elevation −20, and under it are 250 piles from 40 to 60 feet long. The twin piers each called for the sinking of two concrete caissons, from 9 to 10 feet in diameter, the cutting edges of which are from 28 to 40 feet below the bay elevation. Of these caissons, each of which is underpinned by from sixteen to nineteen piles varying in length from 50 to 70 feet, probably 75 per cent penetrated relatively hard clay to reach their seatings. The terminal abutments each have an underpinning of 500 piles.

Ordinarily, caissons used in carrying piers down to footings in open waters are constructed where they are to be sunk and at that time rest on existing soil or on earth placed there for that purpose. In the case of the 238 cylindrical caissons for the twin piers, the work was done in an unusual way. Four piles were driven in a rectangular arrangement about each caisson site and braced and capped. From the caps a platform was suspended, by cables, about 2 feet above the surface of the water, and upon it the cylinder was cast, section by section, until it was high enough to penetrate the bottom and to rise to a prescribed level above the surface of the bay. When thus built and properly cured, the caisson was lifted from the platform and lowered into the water by hand-operated hoists and cables running over triple blocks. There was a hoist at each corner of the platform. As soon as it came to rest, a second section was added above water, and then the cylinder was ready for the final seating operation in the comparatively firm clay of the water bed.

The sinking was done in this manner: Each caisson was loaded with a number of cast-iron rings, weighing all told 35 tons, and dredged out so as to cause it to settle progressively. When it landed on imper-



Austin Bridge Company Photos

STAGES OF CONSTRUCTION

The top view shows a line of twin caissons, their tops just visible above the water line. In the background is the older causeway which for many years has carried all railroad and automotive traffic entering Galveston. In the foreground of the center picture are finished twin-caisson piers tied together by transverse struts and surmounted by reinforced-concrete columns. The bottom picture shows the falsework that was used repeatedly in pouring the concrete for the superstructure in 39 units each 201.5 feet long.

vious material, it was pumped out, the bared bay bottom was leveled off, and the underpinning piles were driven downward from within the structure. However, if the material was relatively soft, and the cylinder could not be pumped out, then the concluding dredging was done with an air lift.

To prevent the soft outlying bottom from running into the caisson as fast as the air lift removed the interior material, the hydrostatic head in the cylinder was held constant with that on the outside by a simple siphon led over the top of the structure and connecting with the water inside and that outside. The air lifts were made of piping, 4 to 6 inches in diameter, and the air was supplied by four compressors which also furnished air for other purposes. When a caisson had been sunk to the required depth and cleaned out, then its supporting piling was driven either vertically or on a batter by means of a power hammer ingeniously arranged to operate in the dry or in water. With that done, the bottom of the caisson was sealed with concrete; and as soon as that was sufficiently set the cylinder was pumped out, if flooded; the tops of the piles projecting above the seal were cut off; the interior was cleaned; and then the structure was filled with concrete and capped. Next the twin caissons constituting a pier were tied together by the massive, reinforced-concrete, transverse strut; the reinforced-concrete column was poured on top of each cylinder; and, finally, the girders and integral deck slab were cast monolithically in 3-span sections.

To facilitate pouring the 201.5-foot superstructure units, the builder devised falsework that could be used repeatedly, as well as steel trusses that could be supported from the tops of the piers as construction advanced. Sand jacks, that allowed a drop of 6 inches, were interposed between the piers and the shoes of the trusses so that the latter could be lowered on to barges when the falsework was to be shifted to another position. In this work there was also employed a unique apparatus that Joe W. Grace, general superintendent of the Austin Bridge Company, has described as follows:

"We had a little steel truss that spanned the entire roadway and sidewalks, that traveled on wheels. On this truss there was a 1-yard hopper that received the concrete and that was moved from one side of the slab to the other by means of an air hoist. This enabled us to distribute the concrete anywhere that it was required on the slabs or walks with only three men. The finishing was done with a regular road finisher that had been extended out to take care of a 40-foot slab. The center to center of wheels on this machine was 46 feet."

Owing to the extensive and complex arrangement of much of the reinforcing steel, it was necessary to compact the concrete within the forms so as to obviate air pockets. This was accomplished by means of No.IV pneumatic vibrators of which a considerable number was required; and I-R air-driven steel brushes and grinders were used to give the concrete a finished appearance, wherever that was specified. During various stages of the project, the contractor utilized Jackhamers and paving breakers, 6A and 9A riveting hammers, and rivet busters. Air-operated impact wrenches, wood borers, saws, sand blasters, and paint sprayers also played their parts on the job—in fact, as Mr. Grace has expressed it: "I think we had practically every kind of pneumatic tool with the exception of air-driven clay diggers."

At the Galveston Island end of the causeway there is a 4,200-foot approach hydraulic fill leading up to the bridging; and at the mainland end there is a similar approach fill that is 700 feet long. Connecting highways on the mainland and the island have been extended to the new crossing, which reaches the bay shore of Galveston Island at a point about 5 miles distant from the business district of the city. The viaduct, like the tributary boulevard from Galveston, has four traffic lanes. The bascule span has a clearance of from 15 to 20 feet, which will make its opening unnecessary for the majority of vessels traveling along the Intra-Coastal Canal. The new causeway will afford the motor-traffic relief that Galveston has greatly needed, and should easily satisfy demands for years to come notwithstanding the ever-growing popularity of the "Oleander City."

The bascule span was designed by Waddell & Hardesty, of New York City; and the construction of the causeway, for the State Highway Department, was under the supervision of T. J. Kelly and Randall B. Alexander.

The author is indebted to Joe W. Grace, general superintendent of the Austin Bridge Company, for many of the details about the building and sinking of the caissons and about the superstructure work.

Gold Mining in British Columbia

R. C. Rowe

V

Rossland

SOMETIME early in the nineteenth century, possibly before 1820, a long since forgotten, bewiskered fur trader found galena ore on the shores of Kootenay Lake. That outcropping eventually became the Blue-Bird Mine; but that was years afterwards and, in any case, does not belong to the present section of this chronicle which is devoted to gold. This apparently disconnected matter is brought to the attention of the reader because the discovery became rather well known due to the fact that "The Honourable Company of Gentlemen Adventurers Trading into Hudsons Bay" (in other words, the Hudsons Bay Company which has figured prominently elsewhere in this history) used the lead ore for making bullets.

The finding of lead ore on Kootenay Lake therefore became almost legendary. It was one of those events that tickle the errant fancy of men because it was shrouded in suitable mystery. The hardy adventurers who wandered across the country at that time knew of the existence of the deposit; but it is certain that very few of them knew where it was. True, it was on Kootenay Lake; but those that had seen the lake (and they were few) were aware of the fact that while it was not very wide it was very long. However, the point is that men had knowledge of mineral in the boundary area of British Columbia a good many years before the gold rush to the Fraser started the province's real mining history.

BRITISH COLUMBIA HIGHLANDS

A lake in an upland valley and two characteristic figures of the mountains. The Indian (above) does his hunting with a gun, whereas the prospector (center) quests for gold with pick and pan.

At this point it is interesting to speculate upon the effect legendary discoveries have upon exploration. So far as the Kootenay is concerned, there is no doubt that, when early gold discoveries stimulated interest in the mining possibilities of British Columbia, many a man started to comb his memory for details of what he had heard about the district from which the taciturn factors of the great fur company were making bullets. Any man who knows anything of mining legends related around camp fires, or in any of the places where men congregate during the restful and lighter hours of life, realizes that they lose nothing in the telling. Hence, there is not the slightest doubt that the inquiring souls just referred to found

plenty to intrigue their interest. It is almost certain that the lead deposits on Kootenay Lake assumed terrific proportions; and it is equally certain that the ore attained a quality of purity that was nothing short of miraculous. That is the way of legends—and a very good way it is, too, because it always sends men seeking. Of course we shall never know just how much that discovery of lead in the Kootenay District contributed to the eventual discovery of Rossland. But it certainly was one of the reasons why men looked for mineral in the region generally, just as the fact that northern Eskimos had been using knives beaten from native copper for many years sent the planes of John E. Hammell searching for copper around Coronation Gulf in the Arctic during our own days and times.

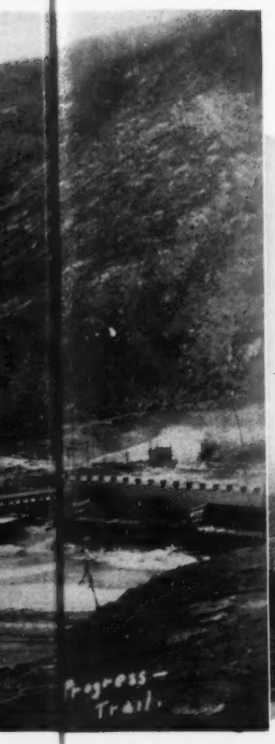
Turning from the realm of legend to that of fact, we find that in the early sixties of the nineteenth century some hardy souls penetrated the Kootenay area in quest of gold and worked some of the streams. In 1865 the Dewdney Trail from Hope on the Fraser to Wild Horse Creek was completed. It was named after E. Dewdney who surveyed the route and who later became the lieutenant-governor of the province. It was built to provide reasonably easy access to the renowned Wild Horse Creek placers that produced more than $500,000 in gold. The route passed close to the site of Trail, the present great metallurgical center of British Columbia, and also near the spot where Rossland subsequently flourished.

For some years there was spasmodic prospecting; and, so far as can be determined, the gossans on Red Mountain (where the lodes that made Rossland famous were finally found) attracted the attention of several of the pioneer travelers along the Dewdney Trail. However, they could find only low values, which were not encouraging in a country so wild and remote. In 1883 there was a good deal of activity at Ainsworth on Kootenay Lake; and in 1886 rich silver ore was discovered on Toad Mountain overlooking the present site of Nelson.

Towards the end of 1885 the last spike was driven on the Canadian Pacific Railway to signal the completion of the transcontinental railway, and its effects were felt immediately. British Columbia at once became easily accessible; and the tales of mineral wealth that had been circulating in the East, instead of being shadowy and unreal, began to assume form and substance. Adventurers started to flock into the Pacific province. In 1887 a trading post was established at Nelson; and men, spurred on by the discoveries on Toad Mountain, began to range the Dewdney Trail and the adjacent country for lode deposits. In 1889 the Lily May was staked. It was right alongside the Dewdney and had attracted all and sundry, having once been named the Tip-Top. Some people may find it hard to understand this nondevelopment of a property beside a well-known trail that had been traveled for more than twenty years; but the writer can only refer them to numerous similar cases in mining history.

It seems to be a fact that the seekings of pioneer prospectors, swayed by circumstances and conditions, follow a definite course. The first waves of prospecting in any remote area are almost always exclusively concerned with precious metals in noncomplex ores or in placers. This is logical, for precious metals in outlying places can be worked profitably because their value is such that they can stand the high transportation costs involved. The search for base metals, or the exploration of precious metals in complex ores, usually follows when shipping facilities have been improved. Early prospectors in British Columbia—that land of great mountain ranges and terrific transportation difficulties, sought only gold in the free state: anything else was merely an interesting mineralogical occurrence to be examined in passing and told about around some distant camp fire. Therefore the mineral deposits along the Dewdney, while known, did not excite the hardy pioneers who tramped its winding course. It needed the completion of the railway, an influx of new blood, and the discoveries on Toad Mountain to change their viewpoint.

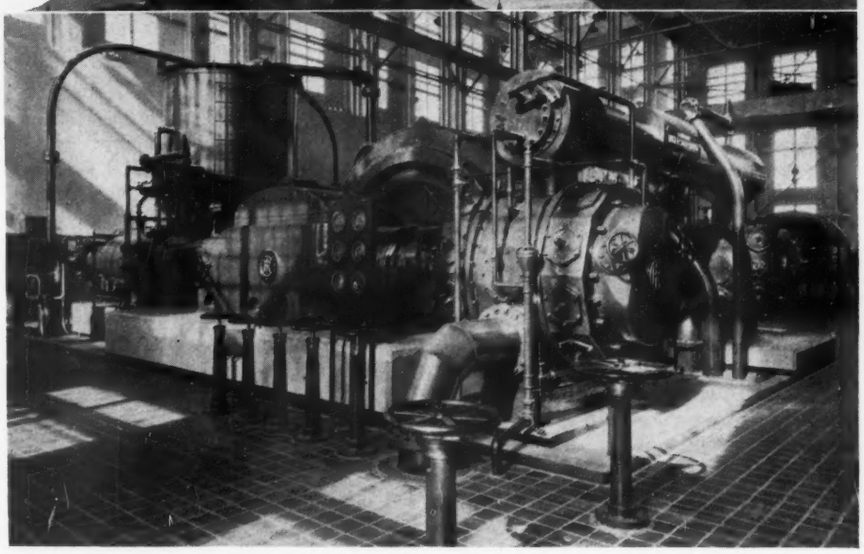
It was undoubtedly these factors which caused Joseph Bourgeois, and one Morris, to stake the old Tip-Top and to call it the Lily May, thus starting a train of events that resulted in the establishment of the great mining camp of Rossland. At this late date we may perhaps be forgiven for a little vagrant wonder as to what woman or women were given some small measure of immortality by Bourgeois and Morris in naming their claim the Lily May. We shall never know, and it really does not matter. Although they worked their claim, they apparently were not particularly impressed with it, for in July of 1890 they crossed over to Red Mountain. In one day they staked the LeRoi (which they called the Louis), Centre Star, War Eagle, Idaho, and Virginia. This, so far as the writer



National Parks of Canada

PARLIAMENT BUILDINGS

Despite its vast size and the sparsity of population in many parts of it, Canada is a well-knit country, governmentally speaking. In these magnificent buildings, in Ottawa, its lawmakers, drawn from varied callings and from every section of the Dominion, assemble to frame legislation.



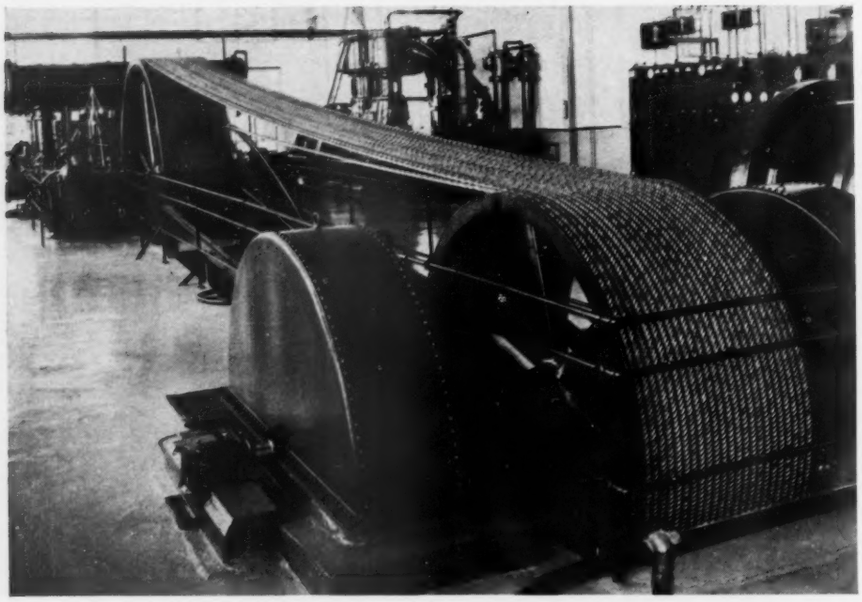
FERTILIZER PLANT AND LARGE COMPRESSORS

Many different but associated enterprises have grown out of British Columbia's mining industry. An important by-product of the great Trail smelter is ammonium sulphate, which is used as a fertilizer. One necessary step in its preparation is the production of synthetic ammonia by subjecting a mixture of three parts hydrogen and one part nitrogen to a pressure of 4,500 pounds. This is done by two 6-stage, 2,250-hp., synchronous-motor-driven compressors manufactured by the Canadian Ingersoll-Rand Company. Each unit has a piston displacement of 4,670 cfm. They are the largest of their kind in Canada. At the upper left is shown the fertilizer plant at Warfield, with Trail at the left.

can determine, was one of the most successful pieces of staking ever carried out in so short a time, for all these names became famous in the annals of British Columbia mining.

The claims were recorded in Nelson, and because the old mining law of the province forbade the staking of more than one claim on the same vein by the same person, the LeRoi was given to Col. E. S. Topping, deputy mining recorder, for paying the $12.50 recording fees. The LeRoi became one of the great mines in British Columbia, which is an interesting example of the little surprise packets that Fate occasionally, very occasionally, hands out to men. Colonel Topping, being a very energetic soul, did not just nurse the property that had dropped into his hands: he proceeded to do something about it. He took samples to Spokane, Wash., where he succeeded in interesting a group of businessmen, headed by Oliver Durant, in the claim. They formed a syndicate and optioned a sixteen-thirtieths interest in the LeRoi from Topping for six months for $16,000. Under the management of Durant, active development took place and 10 tons of ore were sent to a smelter in Butte, Mont. The returns from the shipment averaged $84.60 per ton, and it assayed 3 ounces of silver, 5.21 per cent of copper, and about 4 ounces of gold per ton. The option was immediately taken up, and Topping's remaining interest was purchased by George Turner, Colonel Peyton, W. W. Turner, W. M. Redpath of Spokane, and Alexander Tarbot of Butte. History does not record what these gentlemen paid Topping; but we may safely assume that it was a nice fat sum that was far from any thoughts he may have had on that morning when two prospectors walked into Nelson to file title to five claims when the law allowed them only four.

In the meantime Durant and Tarbot optioned the Centre Star and Idaho from Bourgeois and Morris, and serious exploration began. During 1892 a considerable amount of work was carried on at various properties, the most important then being the Centre Star. The Spokane Falls & Northern Railway from Spokane to Northport was completed that year, and Durant



DUAL-DRIVE COMPRESSOR

This 36-inch stroke machine has been in service since 1905 and is now in the power house of the Sullivan Mine at Kimberley, B. C. Power for driving it is ordinarily transmitted from a water wheel by rope belt. When sufficient water is not available, the unit may be run with steam through a direct-connected engine. Generally, however, a more modern compressor is used when the supply of water gets low.

was instrumental in having a road constructed from Northport to the new camp, thus giving more or less adequate access to the property. Early in 1893 private and government money built a wagon road from Trail, on the Columbia River, to the mines.

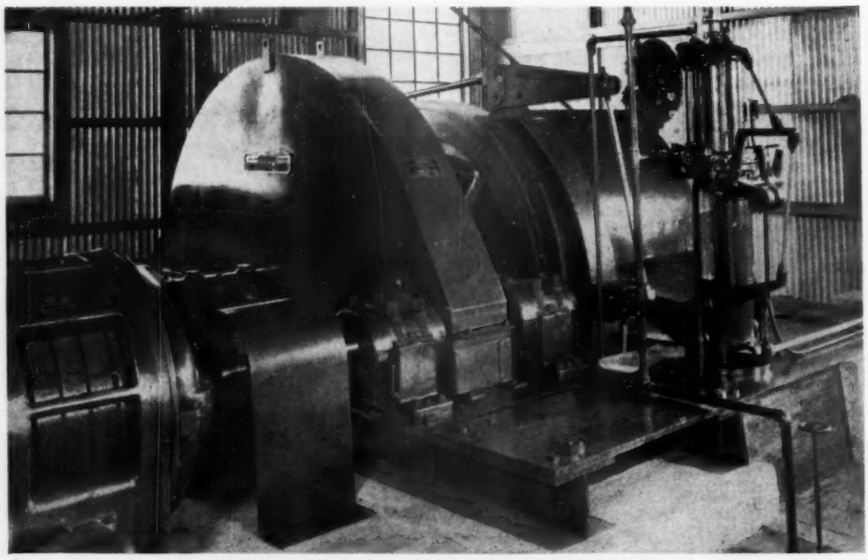
While all this was in progress, a miner named Ross Thompson had seen the light of opportunity. During 1890 he located a preëmption claim of 160 acres, and finally obtained title. He next laid out a townsite and proceeded to sell lots; but they did not move very fast because the future of the camp was still shrouded in doubt despite the high returns from the shipment of the LeRoi ore. Thompson first called his place Thompson, after himself; but the authorities very reasonably objected owing to the fact that a town of that name was already founded in the province. After the peculiar manner of such things, and for no particular reason except that the property belonged to Ross Thompson who was generally called "Ross," the townsite became known as Ross-land, which later became Rossland.

Then came the great panic of 1893, and money for development purposes was as elusive as fireflies on a summer's night. That year was a bad one for Rossland; and its first dim glimmers of glory might have gone out like a light had it not been for the fact that the new wagon road to Trail enabled the LeRoi to ship 100 tons of ore which had accumulated on its dumps. The funds so obtained permitted the mine to continue, and put fresh hope into the camp. In the course of that year the War Eagle was optioned two times; but in each case the option was relinquished.

Money was scarce, and ore was scarcer. Thus 1893 closed rather dismally. In 1894 the War Eagle was optioned by Wakefield Corbitt and associates, together with P. Clark; the Josie claims were sold; and nearly 2,000 tons of ore were shipped. The returns from the latter amounted to $75,510 after deducting freight and treatment costs of $22 per ton. The population of the district grew to 300 souls during the summer of that year; and then, in December, the great ore shoot of the War Eagle was struck. That definitely established Rossland as a great mining camp.

Naturally, 1895 opened on a high note of confidence. The population increased from 300 to 3,000; and there was tremendous activity on a number of properties. Dividends were paid by the LeRoi and the War Eagle, those of the latter totaling $132,000 in seven months. Such profits were enough to start one of those wild bursts of extravagant optimism that are the curse of all mining districts. In the course of the year the LeRoi made a contract with Augustus Heinze, of Butte, for 37,500 tons of ore at a freight-and-treatment rate of $11 per ton, and for an additional 37,500 tons on which the treatment charges were to be the lowest in the market.

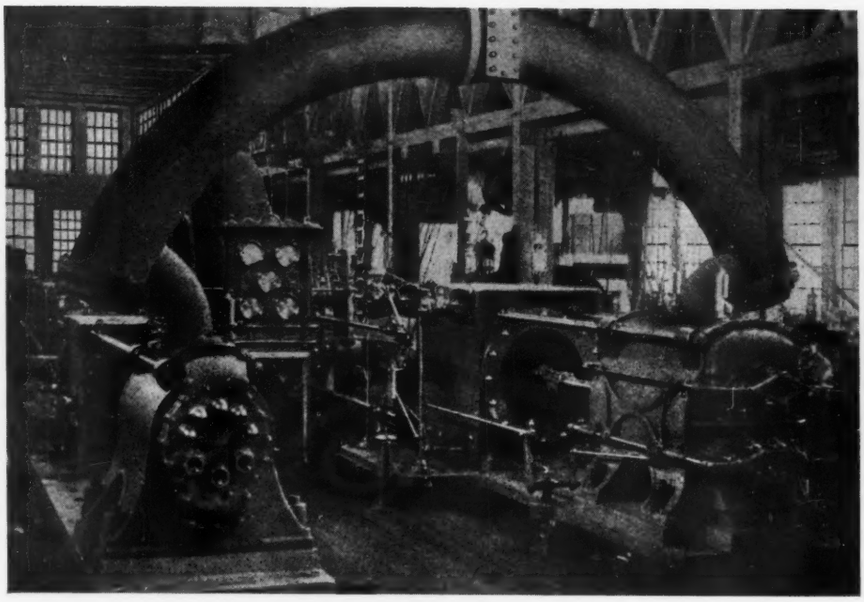
The Provincial and the Dominion governments were keenly alive to the possibilities of the situation, for the former undertook to give Heinze a land grant and the latter a bonus of a dollar per ton if he built a smelter at Trail. With the LeRoi contract offering him the needed security, Heinze commenced the construction of the smelter in October, 1895, and thus laid the foundation for one of the world's greatest mining and metallurgical enterprises—the Consolidated Mining & Smelting Company of Canada, Ltd. Its development from the smelter will be dealt with elsewhere in this history: here it is sufficient to say that the first furnace was blown in during February, 1896, and that a tramming line from the LeRoi to Trail was completed in June. In 1895 the Columbia & Western Railway to Trail was finished, and the following year saw the completion of the Red Mountain Railway connecting Rossland with the Spokane & Northern at Northport.



ELECTRIC MINE HOIST

A Canadian Ingersoll-Rand single-drum, single-reduction geared hoist in a British Columbia mine. The drum has a diameter of 72 inches and a face width of 48 inches. The rope pull is 15,000 pounds and the rope speed 700 feet per minute.

This sequence of events brought the Rossland boom, which began in 1896 and which was a particularly lurid affair. The success of such major properties as the LeRoi, War Eagle, Centre Star, Josie, etc., was hoped for in scores of other less-known claims. For a long time they had lain idle, with the charm of their names reflecting the fancies and dreams of the men who had staked them—the White Bear and the Black Bear, the Annie and the Gertrude, the Rainy Day and the Sunny Side, the Runover and the Nick of Time, the Midnight and the Noonday, the Grand Colt and the Copper Jack, the Green Crown and the Gold Hunter, the Gold King and the Golden Queen, the Evening Star and the Golden Dawn, the Mayflower and the Hattie. But now they, together with many others, sprang into the limelight of publicity. Properties changed hands overnight for fancy prices; and money poured into the district in ever-increasing quantities. A lot of it was spent recklessly and carelessly on deserving claims; and a lot more was squandered foolishly on worthless claims. Stock-market values of the shares of producing companies soared to dizzy heights; and there was a plentiful crop of new promotions. The inevitable reaction set in; and there was the usual clutter of shattered dreams and broken faiths, to be followed by a period of consolidation and the entry into the field of strong, well-managed companies.



"THE SENATOR" COMPRESSOR

This massive machine, driven by a Corliss-type steam engine and made by the Canadian Ingersoll-Rand Company, was set up at the LeRoi Black Bear Mine in 1897. It was named "The Senator" after Senator George Turner, a Rossland pioneer. An identical unit was put in service at the War Eagle Mine in 1896. Both compressors are still operating in the Rossland area. Each weighs 120 tons, runs at the very low speed of 40 rpm., and has a piston displacement of 1,870 cfm. By contrast, modern electric-driven machines of like capacity recently obtained by mines in the district from the same manufacturer weigh only 14 tons and take up only a fraction of the floor space occupied by the older models.

In 1897, when Rossland had a population of 6,000, the LeRoi built its own smelter at Northport and the British American Corporation bought the Josie, Nickel Plate, Great Western, Poorman, West LeRoi No. 1, and the Columbia-Kootenay properties. The next year saw more developments. The Canadian Pacific Railway acquired the Trail smelters from Heinze and reduced smelting charges, which immediately rendered further large tonnages of ore available. In addition, the British American Corporation secured the control of the LeRoi mines and smelters through a systematic purchase of stock which is said to have cost them nearly $4,000,000. Up to this time the mine had paid close to $1,000,000 in dividends. Towards the end of the year the Centre Star was purchased by a Toronto group for $2,000,000. These various transactions give some idea of the faith that powerful and ably directed interests had in the district.

As the twentieth century opened, Rossland ran into difficulties which completely obliterated the last vestige of popular boom. In the first place, the collapse in War Eagle stock towards the end of 1899 started a debacle in share values that ruined a great number of people and shattered faith in the camp on the part of the general public. Then, in 1901, labor troubles arose, with the result that the mines were closed down for a part of the year. By 1902 operations had returned to normal. Meanwhile, however, it was becoming increasingly apparent that concentration of lower-grade ores would have to be effected if the district was to survive, and new experiments in concentration were started in 1903. It is interesting to note that Canada's first installation of bulk oil flotation—forerunner of the flotation process—was made at Rossland. In 1903 LeRoi No. 2 began to use the Elmore method of bulk oil flotation. It was a success from the metallurgical but not from the commercial viewpoint, and gravity concentration was finally resorted to.

From then onward, the history of Rossland becomes one of consolidation and the gradual emergence of one great company as the controlling factor. During 1908 the Consolidated Mining & Smelting Company of Canada, Ltd., took form through the amalgamation of the Centre Star Mining Company and the War Eagle Consolidated Mining & Development Company. In 1911, it acquired the LeRoi, Black Bear, and the LeRoi Star properties; in 1912 it took over the Monte Cristo, Iron Horse, Abe Lincoln, and the Virginia groups; and in 1914, the Mabel, Paul Boy, Eddie J., and the Annie E. claims, not to mention the properties of the Canadian Goldfields Syndicate in Rossland.

Production in the field began to decline in 1917, and by 1927 it had practically ceased. The greatest depth reached was 2,200 feet. In 1927 a large tonnage of low-grade copper ore was shipped to Trail in an effort to keep the mines active. Unfortunately, treatment was not profitable; and since then production has been confined almost exclusively to small shipments by lessees working the properties in a small way. Thus, in 1936, according to the report of the British Columbia Department of Mines, lessees were working properties that were names to conjure with in the nineties of the last century. Among them may be noted the Iron Mask, Centre Star, War Eagle, Josie No. 1, Josie No. 2, LeRoi, Black Bear, and Annie—names sounding over the years as reminders that mines, like men, die. Those listed had an output in 1936 of 9,335 tons which yielded 8,528 ounces of gold and 9,344 ounces of silver.

The Rossland ores were an intimate mixture of gold, copper, and silver; and the district has produced more than 100,000,000 pounds of copper and in excess of 2,500,000 ounces of gold. It has paid several millions in dividends and played a prominent part in the mining development of British Columbia. It provided the foundation upon which the Consolidated Mining & Smelting Company of Canada has been built; and a great many technicians who have become famous had their early training in the mines of Rossland. In some ways it is to the West what Cobalt is to the East—a place of splendid memories where men who have gone high in Canada's social and business world lived their strong young manhood with the adventure of life stretching ahead of them.

This is the fifth of a series of articles by Mr. Rowe. The concluding one will appear in April.

World's Greatest Cathedral Rising in Liverpool

LIVERPOOL, leading city in northern England, bears the unique distinction of having two vast cathedrals under construction at the same time. The Anglican Cathedral, on which work has been in progress for some years, is now approximately three-fourths completed. The more recently started Roman Catholic edifice, known as the Metropolitan Cathedral, is still in its initial stages, with its substructure not yet finished.

These two outstanding churches are rising less than a quarter-mile apart on a ridge of low hills that encircles the older part of the city, forming a crescent of about 2 miles radius from the commercial center on the estuary of the Mersey River. Owing to their elevated positions and their great size and height, they will be the overwhelmingly dominant features of Liverpool's future skyline, as viewed from any part of the city or from the river and beyond.

The two most distinguished architects in the British Isles, Sir Giles Gilbert Scott and Sir Edwin L. Lutyens, are responsible for the designs of the cathedrals. Curiously enough, each is building the church of the creed to which the other belongs. Sir Giles, a Catholic, is acting for the Episcopalians, while Sir Edwin, a follower of the Episcopal faith, is directing the construction of the Catholic cathedral.

It is claimed that the Metropolitan Cathedral will be not only the largest church in Christendom but also the largest building of any kind yet erected by man. In point of volume it will be comparable to the Great Pyramid. It will be in the shape of a Latin cross, providing a central space in which 10,000 persons may be seated. Surmounting it, and constituting its most prominent feature, will be a dome 168 feet in diameter, or nearly 20 feet larger than any existing one. Stainless steel will give the dome a glistening touch of modernity and preserve it against the inroads of corrosion. The four piers of masonry that are to form its support will be so broad that they will be pierced with aisles.

The cathedral is being erected on a tract of slightly more than 9 acres, the site having been received as a gift. The building will cover approximately 5 acres of this plot, and its foundations will all rest on a stratum of solid rock 80 feet thick. The foundation stone was laid early in 1933, and the first work to be undertaken on the project was the construction of the crypt under the sanctuary. The crypt is about 1¼ acres in extent, both it and the sanctuary occupying the entire section of the structure east of the transept. The floor of the crypt is some 15 feet below normal ground level and 30 feet below the sanctuary floor. The crypt will be reached by stairs leading into courts on the north and south sides. Each of these courts will lead directly into a chapel, both of which will have axes at right angles to the main axis of the cathedral. Between the two chapels, on the main axis, are to be two circular compartments. One of these, with its floor 15 feet below the crypt floor, will conceal the organ and choir, while the other

will contain the electrical controls. At the sanctuary level above these rooms will be the choir and chapter house.

The crypt accommodations have been built almost throughout of blue brick, with dressings of light-gray Cornish granite. The latter, both external and internal, is finished with a fine pick face and has 3/16-inch, flush, cement-mortar joints. All the internal walls, save those of the chapter of relics, which is the only part of the crypt not under the sanctuary, will be plastered. The walls of the chapter of relics have been lined with travertine of two colors: golden from Austria, and cream from Italy. The floors throughout are large concrete slabs on which finished paving will be laid.

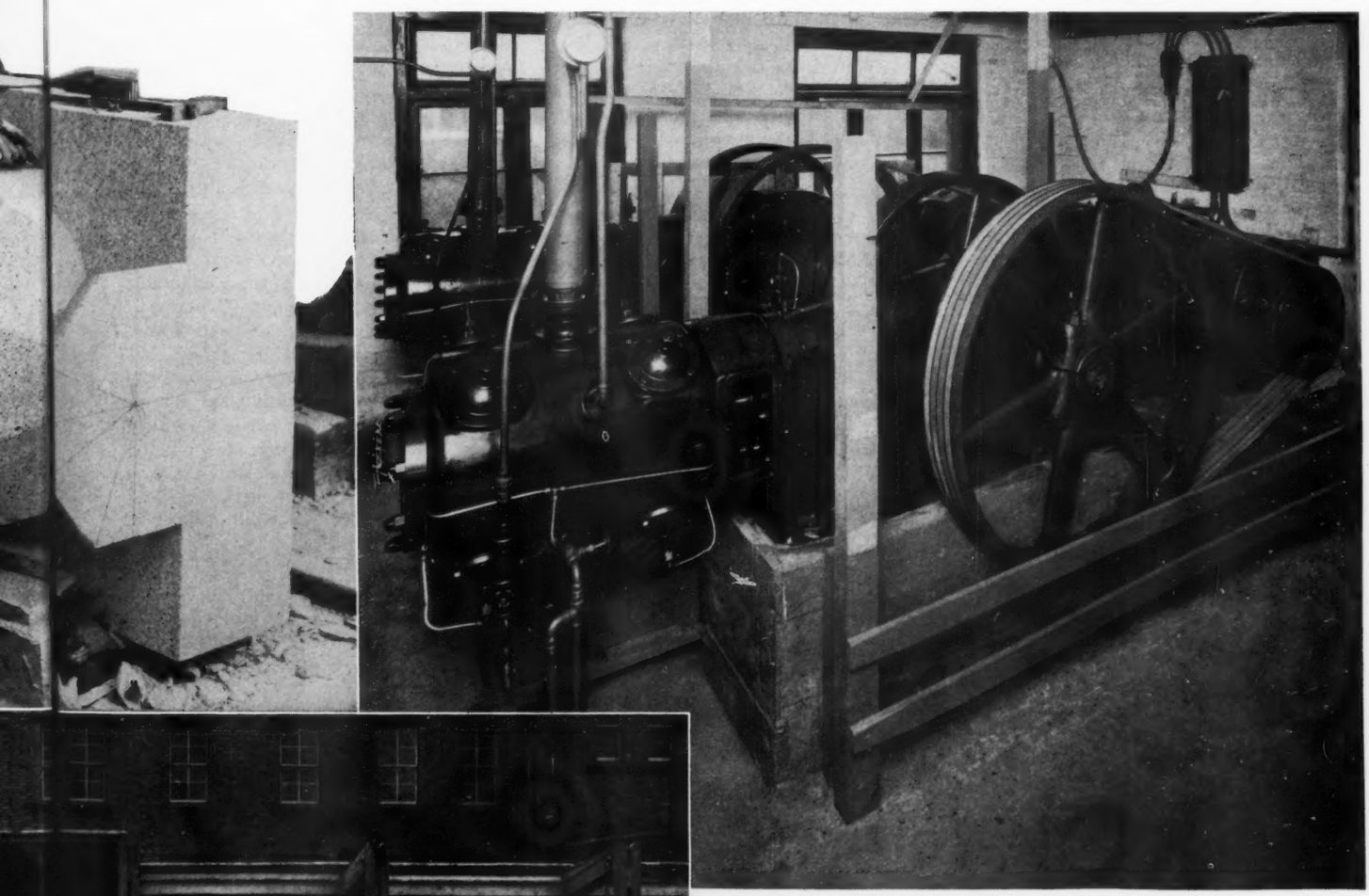
All brick is being set in cement mortar, and the highest quality of workmanship is being specified. More than 2,000,000 bricks have so far been used in the crypt and more than 40,000 cubic feet of granite put in position. Bricks of the Roman type are being employed in exterior walls. These are red in color and are 22x11x1½ inches in dimensions, with some of them attaining even greater lengths.

For heating most of the cathedral, hot-air ducts will extend beneath the floors. These ducts will be up to 6 feet square and will be lined with "fosalsil" slabs to conserve the heat. They will also house pipes to carry hot water to radiators in parts of the building that cannot readily be heated with hot air.

All the arches in the cathedral will have the same proportion of width to height, regardless of their size. The narthex, running the full width of the edifice, will be open day and night for the benefit of destitute persons and will be heated at all times during cold weather. Its outer wall will rise unbroken to a height of 100 feet, where a band of windows will be accentuated with small columns.

The next step in the construction will be the erection of the sanctuary floor and of the sanctuary itself. Then will follow the nave, transept, and dome. It has been estimated that work may be in progress on the Metropolitan Cathedral for from 80 to 100 years. Thus it is possible that four or five generations of workmen may be employed on the structure.

There are approximately 300,000 Roman Catholics in the Liverpool area, and it is reported that this remarkable church will be financed principally by them. The cost of construction has been estimated at $15,000,000.



PREPARING THE STONE

These pictures show sections of the stone-dressing yard which has been set up to work the granite and other varieties of stone that will enter into the construction of the cathedral. Many of the operations are performed with Dallett air-driven tools, of which nearly 50 were in use at the time these views were taken. Compressed air for operating them is furnished by two Ingersoll-Rand Class ES compressors driven by motors through V-belts. The enormity of this building project becomes more evident when it is realized that just the dressing of the stone which will be required may call for the replacement of the compressor equipment three or four times before the undertaking is completed.

SIR HENRI DETERDING

THE career of Sir Henri Deterding, who died February 4 in Switzerland, has been called "amazing," and it certainly was all that. From a $1.20-a-week clerk in a bank at the age of sixteen, he rose to become one of the most powerful figures in the international petroleum industry.

Having decided to cast his lot in service abroad, young Deterding left his native Holland and his bank-clerk's job to go to work for the Netherlands Trading Society in the Dutch East Indies. He was assigned to a remote branch office and given a set of books that was hopelessly muddled. Within four months he had checked back every entry and installed a new set of books. He was rewarded with a 75 per cent salary increase. "Had I let that tough job master me, instead of my mastering it," he afterward wrote, "my whole life would have been different. A minor bookkeeper I was then and a minor bookkeeper I should probably still be. The supreme advantage to me of unravelling those figures was that it gave me the unravelling habit. Only bring the sun of simplicity to shine on your troubles and they soon melt away. Only a small man has time to be complex."

When he was 30, Deterding applied for and obtained employment with the Royal Dutch Oil Company at Penang, Straits Settlements. That concern had been formed six years previously, in 1890, with a capital of $500,000. At that time nearly 50 per cent of the crude oil was reduced to kerosene. That was the only product of value: the remainder was thrown away. American oil interests and the Royal Dutch were engaged in a ruinous price war. The Royal Dutch oil came from nearby; but because of its fine transportation facilities, the American company could put Pennsylvania oil in the Far East at a low price.

Impressed by the advantage that adequate shipping gives in seeking world markets, Deterding effected a union of his concern with the Shell Transport Trading Company, which had a fine fleet of tankers. Thus equipped, he conducted an extensive campaign and obtained a fair share of the business in many parts of the earth. Huge storage tanks were set up at several points in the Far East to aid in making deliveries. In 1937, when he was 71, he retired as the head of an oil empire embracing 200 companies and 40,000 employees.

MANGANESE FROM CUBA

AN ITEM in the annual report of the Freeport Sulphur Company for 1938 is of special interest in view of the current movement to set up adequate national-defense resources. This item states that Freeport's subsidiary, the Cuban-American Manganese Corporation, has succeeded in reducing the cost of producing manganese in Cuba to the point where the company can compete with foreign manganese suppliers, despite a recent sharp drop in the world price of this metal.

Manganese is an absolute necessity in the making of steel. Accordingly, it is the most important of all the so-called strategic metals, even though manganese by itself has no strictly military uses. Also, it is the one metal among all those needed for our national defense of which the domestic supply is most deficient. Ordinarily, the United States produces only from 5 to 10 per cent of the manganese it consumes, and even when spurred on by such an emergency as existed during the World War, the most strenuous efforts to develop ore within the country resulted in an output amounting to only one-third of the consumption.

The chief use of manganese in steel making is as a deoxidizer and desulphurizer. It is generally added to the bath while the metal is being tapped from the furnace, where it combines with the residual oxygen and sulphur and helps to produce a clean, sound metal. Since small quantities of manganese also improve the physical properties of the steel, enough is usually added to leave a small percentage in the finished metal. The amount required varies with the process employed and the type of steel made, but averages around 14 pounds per ton of steel.

Most manganese is sold and applied in the form of ferro-manganese, which contains about 80 per cent manganese and 20 per cent iron and carbon. It is also widely used in the steel industry in spiegeleisen, which is composed of about 20 per cent manganese and 80 per cent iron and carbon. Other commercial forms are metallic manganese, which is about 90 per cent pure, and alloys of manganese and silicon.

The world output of manganese has doubled in the past twenty years, and has reached a maximum of 3,500,000 tons of ferro-grade ore in one year. Curiously enough, not one of the great steel-making nations—the United States, Germany, England, and France—produces within its own borders more than a small proportion of the manganese it uses.

The United States consumption of manganese since the World War has ranged from 300,000 to 600,000 tons of ferro-grade ore annually, in addition to large quantities of lower-grade ore. Russia, India, the Gold Coast of Africa, and Brazil account for more than 80 per cent of the world output of manganese. The nearest of these sources is 4,000 miles distant from the United States; and supplies from Russia and India have to traverse stretches of water that would almost certainly be patrolled in the event of a conflict in Europe.

The chief deposits of high-grade manganese ores in this country are in Montana, and smaller amounts come from Virginia. Lower-grade ores are found in various other sections; but difficulty has been met in reducing them to concentrates with the desired manganese content. The Cuban-American Manganese Corporation has been successful, however, in concentrating Cuban ores of a grade similar to that of the larger deposits in the United States, and it is possible that the processes developed by it can be applied satisfactorily to many of the domestic ores.

Cracked Ice for Mixing Concrete

IN THE November, 1933, issue of this Magazine was an article on a method of refrigeration used by the contractors of the Boulder Dam to cool that great concrete structure so as to prevent the setting up of internal stresses and the formation of cracks. In massive structures of this kind, these stresses are attributable to temperature changes, the greatest of which occur while the concrete is in the initial stages of setting.

Before work on the Boulder Dam was started, it was determined by the U. S. Bureau of Reclamation that the average temperature rise from this cause would be about 40°F., and that 38,600 Btu's would have to be extracted for every cubic yard of concrete placed so as to reduce the temperature of the mass to a safe point. Cooling was done progressively as the structure was poured by first circulating river water and then refrigerated water through small-diameter pipes embedded in the concrete.

This matter is being recalled because Germany is proposing to achieve the same end in a different and what seems to be a simpler way. The first application of the new method is to be made in the case of what will be, it is said, the biggest dam in the country. It forms part of a large hydro-electric project in the Harz Mountains involving the rearing of seven dams. The structure will be 328 feet high and 1,312.5 feet long at the crest. To cool the concrete, the engineers have decided to use finely ground ice instead of water for mixing the cement and aggregates. This, it is computed will give the concrete an initial temperature of from 37.5 to 41°F., or about 35.5° less than that of the surrounding atmosphere. This will be low enough to prevent a critical rise in temperature—that is, dangerous internal stresses—as a result of the heat developed in the concrete through hydration during the initial period of setting.

Enormous quantities of ice will, of course, be required, and this is to be manufactured at the point of use by a refrigerating plant. In this respect, the new system does not differ from that used at Boulder Dam, where a large ammonia-compressor plant was built to provide the necessary cooling water. But, on the face of it, it would seem to be an improvement, as it eliminates the intricate network of piping which, in the case of Boulder Dam, has an aggregate length of 662 miles! It now serves as reinforcing.

Stainless Steel Makes Superior Bellows

AS THE result of a method of manufacture developed by the Chicago Metal Hose Corporation, this company is now turning out bellows—corrugated tube sections—of stainless steel. This alloy is admirably suited for the purpose; but its use has not been commercially practicable heretofore by reason of the difficulties experienced in drawing it into thin-walled tubes. The new 1-piece bellows are produced by seam-welding thin stainless-steel strip into tubing and rolling it to form deep, annular corrugations. This is done by what the company terms the 50-50 principle—that is, the metal, instead of being forced outward only, is spun both inwardly and outwardly from the mean diameter of the straight tube to avoid thinning and weakening the wall, or, in other words, to provide bellows of uniform thickness. In addition, the product has all the desirable qualities of stainless steel—exceptional tensile strength, elasticity, and hardness, together with high resistance to corrosion, heat, and fatigue. The weld, which is made by a special process, is gas and liquid tight.

For special applications and high pressures there are 2-ply bellows, and both the single- and the double-walled types come with either flanged or smooth end, or with cup, rolled-in, or flush neck to which end plates of stainless steel, brass, or copper can be soft or silver soldered. There is a wide range of standard sizes up to 2 inches inside diameter for manifold applications.

INAUGURATING A NEW YORK IMPROVEMENT

Ceremonies marking the beginning of construction of a spacious thoroughfare along the East River shore of Manhattan Island. The picture was taken at the eastern extremity of 55th Street. The Queensboro Bridge is seen in the distance.

Electric Ear

WE ARE familiar with the electric eye, or photo-electric cell; but the electric ear is something unusual. Its function is to differentiate between noises instead of degrees of light, and it becomes operative when sounds normal to properly running machinery become abnormal. It is serving a very useful purpose in a talc mill and in several cement plants in regulating the feed of ball mills; and the indications are that it will soon be used generally in producing finely divided non-metallic minerals.

The device is essentially a microphone, and was developed by the Hardinge Company, Inc., as a substitute for the human ear which is ordinarily depended upon to control the feed—the operator knowing by the sound whether there is too much or not enough material in a mill for efficient operation. The electric ear, however, is far more sensitive, and automatically increases or cuts down the supply when the balls begin to make more or less noise than they should. This is done by converting the volume of sound into electrical energy in a control box. Performance records show that the capacity of grinding mills can thus be increased from 10 to 15 per cent.

Industrial Notes

On January 1, 1939, there were 2,449 airports and landing fields in the United States, or 75 more than a year ago.

It does not sound believable, but statistics have it that $66,000,000 worth of greeting cards are sold annually in the United States. Compressed air is generally used in the industry to apply the colored borders and has been largely responsible for giving us artistic cards at moderate cost.

London is proposing to build another tunnel under the Thames to relieve the traffic now carried by the Blackwall Tunnel that has been in service for more than 40 years. The new river crossing, which is to be about 800 feet downstream from the old one, is to have a 20-foot roadway for south-bound vehicular traffic only, while pedestrians and north-bound traffic are to be routed through the existing tube with its 16-foot roadway. The cost of the project is estimated at $14,000,000.

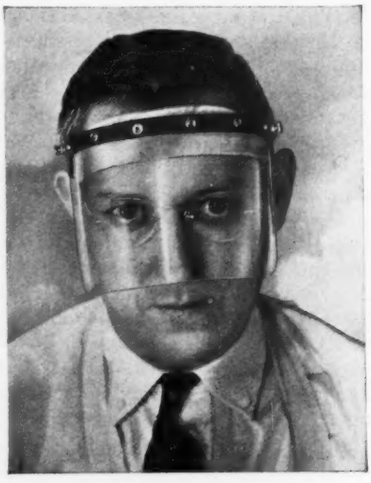
Red lead of an improved quality is being made by the direct vaporization of pure lead in an electric-arc furnace. The lead vapor passes into a precipitating chamber where it mixes with pure oxygen under controlled temperature, pressure, and feed. The product of this new process is said to have higher corrosion resisting properties and, for a given quantity, to cover twice as much surface as ordinary red lead.

Those who are interested in the fixation of sulphur from smelter smoke will find much valuable information on this subject in a recent report—R.I. 3415—published by the U. S. Bureau of Mines. It describes the bureau's experiments, as well as the apparatus and methods used by it in an effort to end a nuisance and to convert a waste material into a useful mineral product. The report also includes a review of recent writings and patents on the recovery of sulphur from gases.

A new method of treating the surfaces of zinc, zinc-coated, and galvanized products before finishing them with lacquer, enamel, paint, or varnish has been developed by the Maas & Waldstein Company. By means of it the parts are either wiped with or dipped in a solution made of a preparation called Zinsol. This compound causes an alloy of zinc and of another metal to form on the surfaces that is said to be chemically inert to moisture, the atmosphere, and organic finishes generally.

For holding such material as plywood panels on machines for sanding, trimming, etc., there has been devised a clamping arrangement that comes in contact with only one surface of the work. Positive grip is assured by the use of vacuum cups, each 3 inches in diameter, which are mounted in two longitudinal rows on a plate which is made to measure and on the underside of which is a manifold which is connected to the main vacuum line. Each cup is provided with a mechanism that renders it inoperative when exposed while in service. This cuts it off from the rest of the system and enables the latter to be used effectively on work that has not the over-all dimensions of the plate.

For men engaged in such occupations as light grinding, wood working, soldering, spot welding, etc., Willson Products, Inc., has designed a light-weight face shield that is both comfortable and adequate. The Protecto-Shield, as it is called, is made of thick, transparent cellulose acetate and gives clear vision in all directions. It is



large enough to fit over prescription spectacles, extends well back along the sides of the face, and swivel joints permit moving it up and back when not in use. The shield is well ventilated and provided with a knitted sweat pad and an adjustable rubber headband, both of which are replaceable.

To test seams in pipes for leaks, there has been devised an ingenious contrivance that has proved to be practical in service. It is a rectangular box of metal with a glass top and strips of soft rubber around the bottom. In making tests, the section is covered with a thick solution of soap suds before the chamber is set over it and connected to a vacuum pump. The suction draws the rubber base tight against the box, sealing it. If there are any openings in the seam, an inflow of air into the pipe as the chamber is evacuated will cause clusters of soap bubbles to appear at that point, thus revealing the leak.

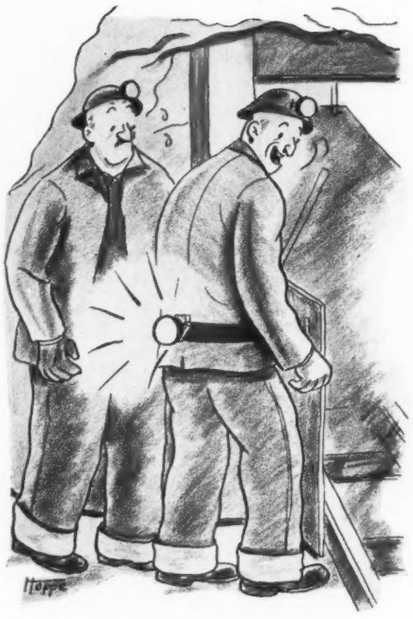
A machine that automatically blends lubricants from many base stocks to exact specifications is the outstanding feature of a plant in Detroit, Mich., designed for the production of special industrial lubricants. The apparatus is set by a series of micrometer dials, much like a radio, for the correct formula proportions; and within a few minutes after it has been connected to the proper storage-tank pipe lines and a switch has been thrown the finished product is ready for delivery by tank car or truck or by barrel. Fifty-thousand gallons of lubricants can thus be variously blended daily to within four one-hundredths of one per cent.

An improvement in Ruggedwear, a material used for resurfacing and repairing concrete factory floors, has been announced by Flexrock Company. The new product contains montmorillonite—a chemical compound of manganese, silica, alumina, and iron—and is said to be tougher and, pound for pound, to cover a greater surface than the older material. It also mixes more readily with cement, sand, and stone, and permits anyone to make patches with a featheredge. Smooth, well-kept factory floors are desirable, especially from the standpoint of safety; and the manufacturer claims that a ½-inch-thick topping of Ruggedwear on concrete will stand up indefinitely under severe service conditions.

The paint shop at Dagenham, England, in which bodies for Ford cars are finished is the last word in establishments of this kind. Only filtered air reaches the individual spray booths, and the volume supplied is slightly in excess of that exhausted so that each compartment is always under just enough pressure to prevent the infiltration of dust-laden air. Walls and floors are covered with a solution of soap, oil, and water that catches and holds vagrant specks of dust, while the inner walls of the drying ovens are coated with castor oil. And to prevent the accumulation of paint fumes on the outside of the building, the exhaust air passes successively through an oil bath, a water spray, and a heater on its way out through the ventilator stacks.

For the convenience of the metallurgist, the George Scherr Company has devised an instrument that is assembled in connection with a camera so that microscopic examinations and photographic records of test pieces can be made with one set-up. The specimen is mounted on a stage at the top of the microscope, and the enlarged image appears in a screen of ground glass which remains in a fixed position at a comfortable angle in front of the investigator. By means of a new device, the Vario-Ocular, it is possible by turning a dial to obtain a continuous series of magnifications up to a maximum of 2,000 diameters. The lamp assembly which provides the illumination can be adjusted to direct the light for either vertical or oblique projection, and the light itself can be varied in intensity from dark to bright.

—Air Jets—



"I got tired of fellows bumping into me."

UP SIXTH AVENUE

The termites gnaw beneath the street
  In costly bites, day after day.
Into the strata of New York
  Relentlessly they forge their way.
The thoroughfares of wooden planks
  On which the traffic hurries past
Conceal a mystic, flood-lit world
  Where workers drill and dig and blast.
Four levels down the engineers
  Carve channels on the rocky floor,
And there are problems they must face
  No builder ever faced before.
They shift and lift the entrails of
  The city's underground domain,
And yet they cannot bind its pulse
  Or halt one elevated train.
When darkness comes and streets are free
  The chasms open up to show
The trussed and cross-beamed wilderness
  With flood-lights streaming far below.
The Diesel cranes with steely snouts
  Move swiftly through the pillared maze.
From shaft mouth to the waiting truck
  A hungry clam-shell bucket sways
Steam shovels lunge against the earth—
  A munching corps that claws and champs
Great mouths of paving, dirt and rocks
  Beneath the sodium vapor lamps.
The sliderule here is coldly king.
  Unerringly it guides aright
The skill and labor of these men
  Who build their subways in the night—

  Only that some day we poor saps
  May hang by our fingers from subway straps.

—DICK DORRANCE
in *New York Sun*

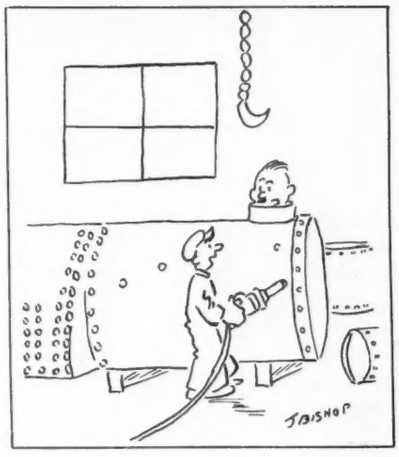
THE MONTREAL RIVER

Written in 1909, when the Montreal River was swarming with prospectors bound for Gowganda. It appears in a collection of verse recently compiled by E. L. Chicanot and published in Canada under the title, "Rhymes of a Miner."

This is the prospector's highway
  Cut out by the Creator's hand,
From Temiskaming's rolling waters
  Way up to the height of land;
Through leagues of dusky jack pines,
  And miles of swampy shore,
Still north and west it winds its way
  Where northern tempests roar.

And its waters sing of the Northland
  As they tumble towards the sea,
A silver song in notes of foam
  Of the lone land, vast and free,
With its unshorn miles of pine land,
  Its mineral treasures rare,
Of prosperous homes and axeman's might
  To shear its valleys bare.
It calls to the hardy prospector,
  It calls to the hungry throng,
It whispers low, as its waters flow
  The pine clad shores along.

Where the smoke of the Indian tepee
  Meets the haze of the northern sky,
And lonely hut and tent are seen
  As the river boat sweeps by
With its load of fortune seekers,
  Who northward turn their gaze,
And follow the Montreal River
  Through its winding forest maze.



"Maybe I should have got out first."

These are the pilgrim fathers,
  The men who go before,
And blaze the trail for the coming host
  As our fathers did of yore.
And the river is now the highway,
  Which carries their hopes and fears.
The canoe is the ark of safety,
  And silver the dream of years.

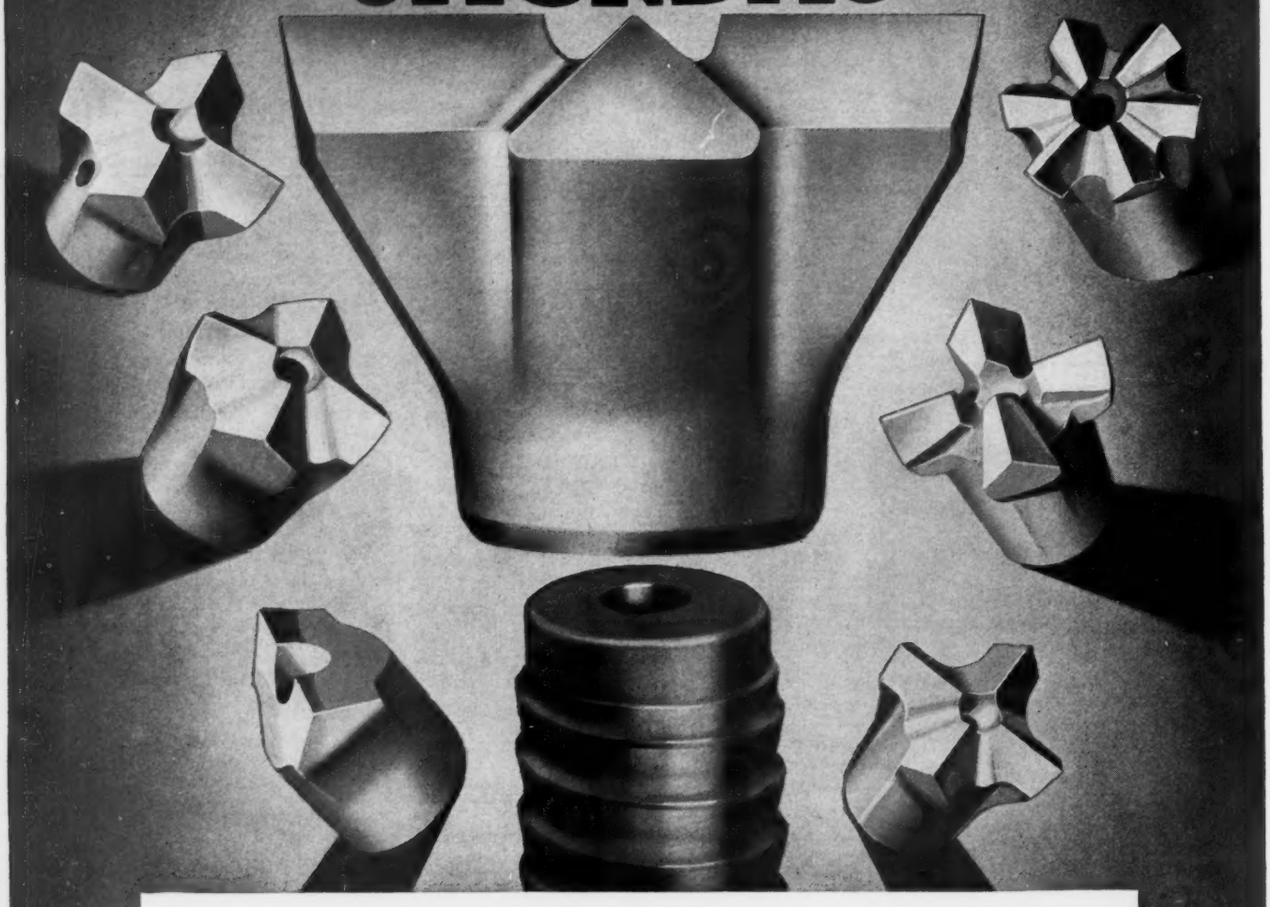
And so, on our mortal journey,
  We dream as the years glide by,
And our lives resemble the river,
  That reflects the northern sky—
To some the reflection is murky,
  To others, the colour is blue,
Let us all sail under our colours,
  In a ship that will carry us through.

—W. MILTON YORKE

"I'm a machine man, and my partner has a fine nose for ore."

THE RIGHT TYPE FOR EVERY JOB

JACKBITS



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TEN GAS COMPRESSORS IN A NATURAL GASOLINE PLANT